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The impact of intergovernmental grants-in-aid on public school expenditure under the segregated school system

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The impact of intergovernmental grants-in-aid on public school expenditure
under the segregated school system

by

Se-Koo Rhee

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
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Department: Economics

Major: Economics

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Iowa State University

Ames, Iowa

1996

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For the Graduate College

*This work is dedicated to My Mother
who has devoted herself to her sons and grandchildren.*

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ABSTRACT

This dissertation investigated the fiscal behavior of local public school districts under the segregated schools system in Maryland with the emphasis on the relative response of school expenditure to intergovernmental grants-in-aid between black and white schools. The median voter model was employed to derive theoretical demand specifications for both nonresidential-property-tax-shifting and partial-shifting assumptions. The theoretical model derived here is unique in the sense that inter-racial factors are included to determine the demand for education in black and white schools, since the provision of public education services was decided simultaneously by the median voter who was presumed to be white.

A pooled cross-section and time series data set from 1929 through 1955 was utilized for empirical estimates of both theoretical models and ad hoc adjusted models. The methods of ordinary least squares and nonlinear least squares were used to obtain unbiased estimates for both no tax shifting and partial tax shifting models, respectively. The simulation of the effect of nonexistence of government policy (grants) was also performed.

The results showed that the expenditure or demand for education in black school districts was much more responsive to intergovernmental grants than in white school districts. Also, the ratio of per pupil expenditure between black and white was one-half in 1929, but almost one in 1955. In addition, simulation results showed that grants had a greater effect on spending for black schools than for white schools. Hence, the equalization of expenditure levels or the reduction of the gap in economic and social well-being between blacks and whites could have been achieved much faster had there been a way to allocate more of

available state and federal grants-in-aid to black schools so as to stimulate the voter's spending on black schools.

CHAPTER I. INTRODUCTION

Economists in the economics of education have identified at least three ways in which education generates a public good. First, the general level of public education benefits each individual in society. Second, education is one mechanism through which the shared norms and common experiences that contribute to social cohesion and stability are inculcated. Thus, education may be said to generate the public good of social cohesion and stability. Third, education may help to redistribute economic outcomes - income and well-being. One way to reduce income inequality is to give some people more education than they would choose or purchase in a perfectly free market. By improving the individual's work skills, education enables one to earn a better living and thus also may improve the quality of one's life. Furthermore, the benefit that one individual derives from the general level of education does not diminish the benefit that anyone else derives from generalized literacy, factual knowledge, political insight, social stability, or equality of economic outcomes. Therefore, the general level of educational attainment in society is a public good, and it is hard to believe that it would be provided in the right amount by an entirely free market economy.

Many researches utilizing the human capital approach have been directed to resolve the relationship between schooling or school quality and subsequent performance - test scores, wage or income. It has been asserted that the difference in schooling or school quality causes the disparity in black-white wages and in well-being in future years (Welch 1973, Orazem 1987). This would be the case if years of schooling completed or school quality were not comparable for blacks and whites simply because of the lower level of per capita schooling

inputs allocated to black schools. Thus, it should be useful to examine the trend of the relative expenditure between black and white school districts in terms of governmental discriminatory policy against black pupils in the provision of public education in the segregated era.

This study investigates the fiscal behavior of local public school districts under the segregated school system in Maryland during the years 1929 through 1955, with emphasis on the relative response of school expenditure to intergovernmental grants-in-aid between black and white schools. The state of Maryland had a unique setting among school systems during this time period. Schools were segregated by race, and school districts and county boundaries were coterminous. The ratio of per pupil expenditure between black and white was almost one-half in 1929 but approached unity in 1955, which was the last year of the segregated school system.

The study may be viewed from a disciplinary perspective and as a policy-oriented empirical investigation. From a disciplinary perspective, its objective is to derive an appropriate theoretical model of local public school expenditure determination under a segregated school system. The emphasis is on the impact of intergovernmental aid on public school expenditure. The policy-oriented objective is to apply the model statistically to investigate the impact of changes in the amount of intergovernmental aid on expenditure levels of school districts. Especially, it concentrates on the relative expenditure between black and white in terms of changes in governmental policy in the provision of public education services.

There has been a refinement of the theory of intergovernmental grants-in-aid in theoretical and empirical studies since the late 1960s. Some predictions of the theory are supported by empirical studies while others are not. There still remains much to be learned

about the response of grant recipients, as every state or locality represents a different institutional setting. To make the logical connection between the theoretical model and the empirical analysis, this study follows the approaches of Barr and Davis (1966), Bergstrom and Goodman (1973), Perkins (1977, 1984) and Turnbull (1987), but mainly Borchert and Deacon (1972). This approach permits the use of the pooled cross-section and time series data of the segregated school districts in the estimation.

This study extends the public choice approach to the area of public school finance. It derives theoretical models which include the inter-racial factors to determine the separate demands for education of black and white students. There are only a few studies that deal with racially segregated school systems. Margo (1982), Pritchett (1985), Fishback (1989) and Gerber (1991) investigated the trend of demand for education and changes in relative educational expenditures. However, they dealt with the southern states at the turn of the century, from the late 1800s to early 1900s, which is quite different from this study geographically and in the period of time covered. Thus, their results cannot be compared directly to the results of this study.

This study utilizes a comprehensive data set of pooled cross-section and time series for a 27-year time period, 1929 through 1955, to test the theoretical predictions of the models. Whether or not the results are consistent with the theory and those of other studies will be of interest. Although the results of the models employed in other studies may be valid, they may not be relevant to Maryland's segregated school system of this time period.

In Chapter II, an overview of intergovernmental grants-in-aid will be presented. The role of government and types of grants in public school finance are discussed. Discussion of

the policy relevance of the impact of grants is followed by review of the empirical literature on the subject, with special attention on the impacts of different grants on education expenditure. The median voter hypothesis and criticism of it are presented in Chapter III. The empirical specification problems involved with education are also discussed. A theoretical model of local education expenditure and the actual specification of the expenditure equation to be estimated are derived in Chapter IV. The data, sample statistics, and econometric results are discussed in Chapter V, and the summary and conclusion are discussed in Chapter VI.

CHAPTER II. INTERGOVERNMENTAL GRANTS-IN-AID: THEORY AND REVIEW

A. The Role of Governments in Public School Finance

The general economic view of local government finance is that decentralization allows the provision of public services to reflect the variety of individual preferences, since local governments can select different levels of services and individuals can choose their own area of residence.

Although the level of local spending may not be efficient, given fixed jurisdictional boundaries, interjurisdictional externalities, and means of local budget determination, fiscal decentralization remains the only alternative to the insuperable problem of determining the optimal level of expenditure on public services provided by a central government.

The financing of public education in the United States involves federal, state, and local government funds. Public elementary and secondary education is provided by more than 16,000 local school districts. Most of these are independent special-purpose units of local government with authority to levy taxes and set their own budgets. The remaining districts, although subordinate to municipal or county governments, are generally controlled by separate local governing boards and also have considerable financial autonomy. While public schools are a state responsibility in general, the school financing system is a decentralized one in which state authority is exercised indirectly. The states take constitutional responsibility for education by charging state legislatures with maintaining uniform systems of common schools. Typically, the states make elementary and secondary schooling compulsory, and develop a set of laws regarding curriculum, personnel, and other facets of their operation. Those are the rules according to which local school districts or

educational agencies may determine budgets and set taxes. The states share the burden of financing by providing grants-in-aid to the districts and impose restrictions of varying severity on how state and local funds can be used. But most states leave their districts wide latitude to determine the levels at which they will fund public schools and the tax rates they will impose.

The federal government's role in the school finance system is minor compared to the roles of states and localities. It consists mainly of providing an assortment of special-purpose categorical grants, most of which are channeled to the local districts via state agents. The rationale for federal grants to education is based on the fact that the nation may place relatively different priorities on some educational issues than the state and local educational agencies. Grants represent one method of getting state and local educational agencies to address federal concerns through the tailoring of specific grants to those governments to provide subsidies for services that fulfill the national priorities. Other rationales are discussed in the following section. However, there has been an argument that increased federal funds - especially during the decade 1965-75, called the period of "creative federalism," and after that period - would necessarily lead to lessened local control of schools and to making decisions with poorer information about demands and educational needs in each local area.

B. Theory of Intergovernmental Grants-in-Aid

1. Types and effects

In general, there are two rationales for intergovernmental grants (Gramlich 1977). First are economic justifications, where higher-level government could have efficiency, equity,

or stabilization objectives that impinge on lower governments in various ways. The (open-end) matching grants, and unconditional (general) grants or closed-end lump-sum transfers are in this category. Second are political or institutional justifications, where lower-level governments are viewed as agents of higher-level government policy. The closed-end categorical grants are of this kind. Standard indifference curve theory, which reflects the preferences of the decisive voter and is assumed to be a function of the preferences of others in the community, can be used to indicate the effect of these different type of grants on the budgets of lower levels of government.

a. (Open-end) matching grants

Matching grants refer to a mechanism whereby a higher-level government would provide a specified proportion of the expenditure of a lower-level government in an area of concern. Matching grants denote the proportion of local expenditure that a higher-level government will pay (match) for each category of services. Definitions of which services are eligible, the matching rates, and the appropriate accounting system for reporting expenditures are all that is required from a regulatory standpoint. The justification for the matching grants is benefit spillovers. The general idea is that not all of the benefits of a local expenditure are captured within the community. Therefore, other community or higher-level governments should subsidize this good or service.

These grants alter the relative prices facing lower levels of government. If there is a reduction in the relative price of the grant-aided good, expenditures will increase by an amount depending on the price elasticity of demand. If expenditure demand is price elastic,

total (all of lower and higher levels of government) expenditures on grant-aided goods will increase by more than the grant, and expenditures on all other goods will decline; vice versa if expenditure demand is price inelastic.

Examples at the federal level include public assistance and medicaid. Some state governments have these kinds of grants in the area of education and other social services. Since most of these grants are open-end, the level of grants is determined simultaneously with the level of expenditures.

b. General (unconditional) grants, or closed-end lump sum transfer

The second economic justification regards the distribution of income to either all income groups more or less proportionately, or to any specific income groups, especially to low-income groups somewhat disproportionately. If the public services (health, education, public safety, or others) should be provided at equal cost in the two communities, or more cheaply in low-income communities from the social point of view, the higher level government will have a reason to redistribute income among communities - giving to low-income communities, and taking away from or not giving to the high-income communities.

A revenue sharing program more focused on poor jurisdictions could be justified by an extension of this argument. Revenue sharing refers to the federal government returning a portion of federal revenues to state and local governments to use as they see fit. The notion behind it is less a national concern with regard to the state-local provision of particular goods or services than it is a sharing of national tax sources with other governmental units.

Accordingly, revenue sharing is not a system of grants to support particular public goods as much as it is an approach to augmenting state and local government revenues. In that sense, it can be used to increase any or all public goods, as well as to reduce local tax effort through financing of expenditures that would have been funded from state-local revenues. The effects of revenue sharing on any specific expenditures will depend on the relative preferences of state-local governmental units for various public goods or services. Economists generally view the effects of revenue sharing on public expenditures as similar to that of any increase in community income.

Since these grants change the income of the community and not relative prices, the change in expenditures will usually be less than the grants if both public and private goods have positive income elasticities. Even though the response of expenditures is smaller than with the same-sized grants of the open-end matching type, such a grant is used to redistribute income among jurisdictions, since the lack of restriction on spending allows each community to maximize its own welfare.

The federal revenue-sharing block grants and state aid to local general governments or school districts in many states are examples of these types of grants.

c. (Closed-end) categorical grants

While the forgoing arguments have played a role in the development of central government grant programs, a political or institutional justification has probably played an even more important role in most developed countries. There are some good democratic reasons to try to keep power close to the people by having strong and vigorous local

governments. At the same time, high-level or central governments have tried to establish the minimum service or spending levels for government-provided goods or services. A reasonable way to compromise these partially conflicting objectives is for the central government to give (closed-end) categorical grants to local governments. This preserves local control over the relevant functional category of expenditures, yet allows the central government to upgrade local spending. While it is reasonable to expect that some portion of categorical grants will support the services for which they were intended, some will be used to release resources for spending on other public goods or services, and some will be used to reduce the tax burden by replacing state-local funding that would have been provided. The exact distribution will be difficult to ascertain because of impossibility of separating expenditures on the intended category or services from those for other services in the area intended where such categories are not readily separable.

However, by nature of the objective of the grants, a closed-end grant does not allow the local government as much freedom as an open-end price reduction grant, and the central government maintains control over its own budget by limiting the total amount of funds available to local governments. Thus, the central government typically establishes rather tight conditions on the uses to which the money can be put and the degree to which local governments can cut back other spending. These grants may be regarded as a device by which local governments are acting as the agents, contractors, or fiscal partners for the central government in carrying out the specified tasks.

The closed-end categorical grants are affecting both income and/or relative prices facing lower levels of government. As long as the community operates within the budget

constraint set by the matching program, the grant has a price effect. However, if the community spends all the money available from the grant or there is no matching requirement, then the analysis is the same as the above unconditional grants. The response of expenditures to these grants would show somewhat the intermediate possibility. Traditionally, the most important type of grants at the federal level have been the closed-end conditional grants in such areas as highways, health, education, manpower, and the environment. State governments also provide categorical grants to local agencies that are tied to specific programs or services in education.

This simplistic view of the effect of grants might be flawed since it assumes that the indifference curve reflects interests of the decisive voter or agency (manager) and that they are identical to the interests of other constituents in the community. Thus, the model described above is likely to be a poor predictor of government spending behavior, at least in the short run. After all, the simple model predicts that a dollar increase in grants has the same effect as a dollar increase in community income. However, grants often lead to a greater spending increase than would result from an equivalent increase in community income. This phenomenon is called the “flypaper effect,” since it describes the situation in which money tends to stick where it initially hits.

To summarize, higher-level governments use a different set of grant types to increase the provision of public goods or services by lower-level governments. Each has the potential for increasing the amount of specific types of goods or services that are produced, but each also has the potential for supporting the provision of other public goods or reducing local tax burden.

2. Types of grants in public education

a. General state aid

Most state aid to local school districts is unrestricted aid for general-purpose support of current operations. There are also a variety of categorical grant programs providing aid for particular groups of children or types of school services. Nearly all aid funds, both general-purpose or categorical, are distributed among districts according to formulas written in state law. There is very little discretionary funding.

Flat grant In most states, general state aid is provided in lump sum form. That is, the amount of aid to which a district is entitled does not depend on the district's own fiscal decisions. Some general aid is provided to all local educational agencies in the form of so-called population membership grants or average daily attendance (ADA) grants, or flat grants. The state provides a flat amount of grant assistance for each child attending the school district or in average daily attendance.

Foundation program or equalization grants But most states have developed lump sum formulas with equalizing properties. This means that the amount of aid per pupil varies from one district to another according to some measure of each district's own ability to raise revenue for its schools. Since property taxes are the main source of local revenue, the measure of local ability is usually the amount of assessed property value per pupil (the local tax base). A few states, however, use other wealth indexes. Under the most commonly used equalization

scheme, known as the *foundation formula*, the amount of aid per pupil to which a district is entitled decreases linearly as a function of the local tax base, within upper and lower bounds.

Percentage equalization In some states, lump sum grant formulas have been supplanted by systems, namely *percentage equalization formulas*, in which the state matches school revenue raised locally. Each local school district establishes its own expenditure level within state limits, and the state equalizes the expenditure by providing state funds based on the district's relative fiscal capacity. Thus, whereas the foundation program is a fixed unit formula, the percentage equalization is a variable unit formula. With the form of variable formula, the matching rate decreases linearly, within the state limits, as a function of a district's assessed property value per pupil. Since the formula was first advanced seriously in 1922, only seven states have adopted it for use as a basic aid formula: Iowa, Massachusetts, Maine, New York, Pennsylvania, Rhode Island, and Vermont.

District power equalization District power equalization is a method of equalizing tax bases so that all school pupils will have access to the same resources or face the equalized per pupil revenue among school districts even though the tax base per pupil may differ. It premises the removal of wealth as a determinant of the use of local school revenues, to equalize completely tax resources among all school districts. In theory, there is no difference between the foundation program and percentage equalization, because if both were geared to the wealthiest district in the state as the key district, then full equalization would take place. However, the practicality of financing has never allowed this to happen, because to level-up to the richest requires an inordinate amount of tax resources in most states. Only Wisconsin

enacted this plan in 1973, but it was short-lived because the recapture provision was held to be unconstitutional by the Wisconsin Supreme Court before the law became effective.

b. State categorical aid

State categorical grant programs provide special-purpose aid for designated groups of pupils (e.g., handicapped, gifted, or disadvantaged children), for specific educational programs (e.g., vocational education or bilingual education), and for specific school district functions (e.g., pupil transportation or school construction). Most of this aid is distributed according to formulas that reflect the need for the category in question (e.g., number of pupils in each designated category) and/or the cost of providing the service (e.g., actual expense of pupil transportation).

c. Federal aid

Unlike state aid, most federal aid is earmarked for specific purposes. The largest federal categorical grant programs have been for compensatory education, vocational education, education of the handicapped, preschool education ("Head Start"), and innovative projects. On the other hand, the only large, federal general-purpose aid program is the aid to "federally impacted areas," which distributes general-purpose funds on the basis of the number of children of federal employees in a district. Another difference between federal and state aid is that most federal aid is not distributed directly to districts by formula. Rather, a typical arrangement is to allocate aid among states by formula. Then, on a project-by-project base,

aid is distributed to eligible districts that submit applications. There are considerable variations in arrangements from one program to another.

The federal government has restricted its use of matching grants to a portion of its vocational education grants to the states. The main theoretical advantage of matching grants is their efficiency in tying the assistance to increased provision of a service that is of national concern. From the point of view of the individual district, however, federal aid in nearly all cases takes the form of a categorical lump sum grant.

C. Intergovernmental Grants-in-Aid for Education

1. The policy relevance of the impact of grants-in-aid

The reason that intergovernmental grants are so important in school finance is that they are the main instruments by which state and federal authorities can influence the level, distribution, and utilization of educational resources. Changes in an existing grant system, either amount or form, are usually proposed with one or more of the following objectives in mind: (a) to increase aggregate or average school support, (b) to provide tax relief to local property taxpayers, (c) to modify the distribution of educational resources among districts, to reduce disparities, or (d) to direct resources to specific educational activities of special interest to the aid grantor.

A study of grant impact is, in essence, an inquiry into the local response to changes in the amount or the form of aid. With their fiscal autonomy and access to a local revenue source, local school districts are able to respond adaptively to any changes in external financial support. Their adaptive behavior may include raising or lowering the amount of revenue they obtained internally

by raising or lowering the property tax rate, and raising or lowering the amount of non-grant funds allocated to the categorically aided function in response to the change in categorical grant. These induced changes may or may not be compatible with the grantor's objectives. In general, unless the local response is anticipated correctly and allowed for in establishing state and federal aid policy, the outcome may be quite different from what the grantor intended. In the following section, the impact of intergovernmental grants on educational expenditure is assessed by reviewing and synthesizing the empirical literature on the subject.¹

2. Review and synthesis of the empirical literature

There are two kinds of studies that set out to evaluate the impact of intergovernmental grants on educational spending. The first restricts its focus to the determinants of educational expenditures only, while the second considers the determinants of total state and local government expenditures and for several selected subcategories including education.² Both kinds of studies on education are included here. These studies focus on different types of government units, and employing different methodologies. They include both cross-sectional and time series studies.³

The earlier studies are characterized by the "determinants" approach to the study of educational expenditures of state and local governments. The typical determinants study consists of a single-equation regression model explaining educational expenditures⁴ on a per capita or per pupil base in terms of some independent variables, including intergovernmental grants, income, population density, property wealth, and others. Using a least squares estimation technique, they generally have shown strong and significant effects of

intergovernmental grants. However, the precise findings from these studies should not be accepted without considering the possible biases created by their conceptual and statistical problems. A common problem has been the lack of an adequate theory of the underlying fiscal behavior of state and local governments. The lack of an adequate theory behind the regression model makes it difficult for the researcher to determine the causal relationships among the variables. Many studies also have not attempted to distinguish the effects of different types of grants. Since different types of grants tend to have different impacts on the level of educational spending, the design of an intergovernmental grant scheme must take into account the form of grant. Moreover, since most of these are cross-sectional studies for a single year, the results might not be applicable in predicting the spending behavior of local governments or school districts over time.

Studies since the late 1960s have paid more attention to those problems than earlier works. In these studies, some theoretical consideration has been given to the spending and taxing behavior of local governmental units. Some of these latter studies have set up a system of simultaneous equations that recognize explicitly the interplay of supply and demand forces affecting educational expenditures. A two-stage least squares procedure is then used to estimate the impact of various factors affecting the level of educational expenditures. Some authors also have chosen to specify an educational demand function based on a median voter, majority rule model. Voting models have been most popular in the applied public demand and grant literature. Others have constructed a bureaucratic model, or budget maximization model. This is a utility maximization model that depicts a government unit or a bureaucrat as seeking to maximize the welfare of its constituents subject to some fiscal constraints (Barro

1972, Johnson 1979, Niskanen 1971). Others have proposed interest group models that view the social decision process as serving the needs of a particular power group in the community.⁵ Besides making an effort to model more adequately the spending and taxing behavior of local governmental units, some of the studies also have attempted to differentiate the effects of different types of grants.

Since the results of a cross-sectional analysis are inadequate for predicting the spending behavior of a local government over time, because long-period time series data are either expensive or difficult to obtain, some authors have tried different statistical methods to deal with this problem. One method is to combine cross-sectional data for several years into a pooled cross-sectional, time series form of statistical analysis. Pooling the data for several years together generates more variance in the data set for statistical analysis. Another method is the "change" analysis, which uses data in "change" form. That is, changes in expenditure levels between two selected years are related to changes in explanatory variables between the two years (Adams 1979). In short, compared to earlier ones, later studies have used more elaborate models of the fiscal behavior of state and local governments and have employed more sophisticated statistical techniques in their empirical estimation of the impact of intergovernmental grants on educational spending.

In general, the numerous previously published studies reviewed in this study have found significant effects of several factors on educational expenditures. Total educational expenditure is related positively to intergovernmental grants for education, related negatively to the price of education services faced by a local district, and directly related to the level of income or property wealth. The level of educational expenditure also is affected by the

composition of the local tax base; a district with a lower proportion of residential property (and a higher proportion of commercial property) tends to spend more on education. Other commonly-used variables that have been found to be important are the age composition of the population, population density, and the extent of urbanization of the region.⁶

In the sections that follow, empirical studies are grouped into two categories: studies of state grants to local governments or school districts, and studies of federal grants to state and local governments. Each study will be introduced with the specific problem it addresses, the model constructed, and the statistical procedure used. Since the focus is on the intergovernmental grant variable, primary emphasis is given to an examination of the empirical effects of different types of intergovernmental grants on educational expenditure.

a. State grants and educational expenditure

State governments long have been a major source of funding for education, and, as discussed earlier, most state education grants have been awarded to local governments or school districts in the form of foundation or equalization grants. The states also provide general aid in the form of flat grants based on population membership or average daily attendance (ADA). Both foundation grants and flat grants essentially are unrestricted block grants. There also are state categorical grants in many states, but they are nominal relative to foundation or flat grants.

The studies of state grants reviewed here have used total educational expenditure per pupil or per capita as the dependent variable, except for Stern (1973), Bowman (1974), Grubb and Michelson (1974), and Cohn (1974). Stern, Grubb and Michelson, and Cohn have used

locally financed educational expenditure as the dependent variable, while Bowman has used school district tax.

The studies can be divided into three subgroups: (a) studies of the impact of state grants on educational expenditures by state governments (Renshaw 1960, Sacks and Harris 1964, McMahon 1970, and Cohn 1974), (b) studies of the impact of state grants on educational expenditures of cities and Standard Metropolitan Statistical Areas (SMSAs) (Brazer 1959, Bishop 1964, Sacks and Ranney 1966, Campbell and Sacks 1967, Pidot 1969, Hu and Booms 1971, Sacks, Ranney and Andrew 1972, and Weicher 1972), and (c) studies of the impact of state grants on school district educational expenditures. However, the first two groups of studies are not presented here. A limitation of the first group of studies is that their state-level data are too highly aggregated. Decisions about expenditures, school size, enrollments, and other education-related issues are made usually at local levels (school districts, cities, and counties). Thus, to understand the behavioral patterns of local education organizations, one has to analyze data for local educational units rather than state aggregates. The second group studied the educational expenditure patterns of cities and SMSAs. Education is one of several functions of a city government, but it is the major function of a school district. Thus, decisions of a school-district government regarding educational expenditures are likely to take place in an environment different from that of a city government. For these reasons, these two groups of studies are omitted here.

Table 2-1 summarizes empirical studies on the impact of state grants for educational expenditures of school districts. All estimates presented here are statistically significant at the 5% level unless stated otherwise. One early study, by Miner (1963), considered the

Table 2-1. Empirical studies of the impact of state grants on school district educational expenditures

Study	Data (cross-sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant,G)	Response (marginal change, dE/dG)
Adams (1979)	school districts in Maryland, 1972 to 1976 (pooled data)	per pupil total expenditure	per pupil state block grant for education	between 0.6 and 0.7 (elasticity=0.157)
			per pupil state education categorical grant	0.7 (elasticity=0.074)
	school districts in Kansas, 1973 to 1975 (pooled data)	per pupil total expenditure	per pupil state education categorical grant	0.5 (elasticity=0.039)
	school districts in Colorado, 1977	per pupil total expenditure	price of education services	elasticity=between -0.09 and -0.08, insignificant
			per pupil state education categorical grant	0.17 (elasticity=between 0.021 and 0.019)
Adams (1980)	school districts in Wisconsin, 1973-1974 and 1975-1976 (pooled data)	per pupil total expenditure	price of education services	elasticity=between -0.22 and -0.19
	school districts in New York, 1976-1977	per pupil total expenditure	per pupil state education categorical grant	1.7 (elasticity=between 0.063 and 0.086)
			per pupil state block grant for education	0.59
			per pupil state education categorical grant	1.06
Addonizio (1991)	345 school districts in Michigan, 1982-1983	per pupil total expenditure	per pupil state block grant for education	between 2.28 and 2.36 for in-formula districts
			price of education services	elasticity=between -0.09 and -0.11 (for in-GTB-formula)
				elasticity=between -0.24 and -0.36 (for out-of-formula)

Table 2-1. (Continued)

Study	Data (cross-sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant,G)	Response (marginal change, dE/dG)
Black, Lewis, & Link (1979)	school districts in Delaware, 1970-1973 (pooled data)	per pupil total expenditure	per pupil state block grant for education	0.77 (elasticity=0.66)
Bowman (1974)	55 countywide independent school districts in West Virginia, 1969-1970	per pupil school districts tax	per pupil state block grant for education	tax decreases by 50 cents per dollar of grant (elasticity=-0.803)
Cohn (1974)	67 counties in Pennsylvania, 1970	per pupil locally financed expenditure	per pupil state grant for education	-0.12, significant at 10% level
Feldstein (1975)	105 towns in Massachusetts, 1970	per pupil total town expenditure per pupil total town expenditure	per pupil state block grant for education price of education services	0.6 (elasticity=0.066) price elasticity= -1.0
Grubb & Michelson (1974)	159 school districts in Massachusetts, 1968-1969	per pupil locally financed expenditure	per pupil state block grant for education per pupil state education categorical grant price of education services	-0.74, insignificant 1.21, significant at 10% level elasticity=0.5, insignificant
Grubb & Osman (1977)	234 unified school districts in California, 1971-1972	per pupil total expenditure	per pupil state block grant for education	0.78

Table 2-1. (Continued)

Study	Data (cross-sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant,G)	Response (marginal change, dE/dG)
Ladd (1975)	78 communities in Massachusetts, 1970	per pupil total community expenditure	per pupil state block grant for education	0.5 (elasticity=0.03)
		per pupil total community expenditure	price of education services	price elasticity=between -0.65 and -0.49
Megdal (1984)	177 school districts in New Jersey, 1970, 1974 and 1977 (pooled data)	per pupil total expenditure less tuition revenue	per pupil state block grant for education	elasticity = -0.06
			price of education services	elasticity = -0.28
Miner (1963)	1127 school districts in 23 states, 1959-1960	per pupil total expenditure	state educational aid as a percentage of total educational expenditure	negatively related
Park & Carroll (1979)	451 school districts in Michigan, 1971 to 1976 (pooled data)	per pupil total expenditure	per pupil state block grant for education	0.06 (elasticity=0.005)
			per pupil state education categorical grant	0.32 (elasticity=0.017)
			price of education services	-0.02
Perkins (1984)	112 communities in Massachusetts, 1970	per pupil total community expenditure	per pupil state block grant for education	elasticity = 0.013
			price of education services	elasticity = -0.704
	307 communities in Massachusetts, 1970, 1973, 1975 and 1976 (pooled data)	per pupil total community expenditure	per pupil state block grant for education	elasticity = 0.01 (OLS) elasticity = 0.01 (dummy variable model)
			price of education services	elasticity = -0.65 (OLS) elasticity = -0.56 (dummy variable model)

Table 2-1. (Continued)

Study	Data (cross-sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant,G)	Response (marginal change, dE/dG)
Stern (1973)	157 school districts in Massachusetts, 1968-1969	per pupil locally financed expenditure	per pupil state block grant for education	between -0.55 and -0.45
Struyk (1970)	140 school districts in New Jersey, 1965-1966	per pupil total expenditure	per pupil state aid	0.65, insignificant
Vincent & Adams (1978)	school districts in Colorado, 1973 and 1975	per pupil total expenditure	per pupil state education categorical grant	1.6 for 1973
		change in per pupil total expenditure between 1975 and 1973	change in per pupil state education categorical grant between 1975 and 1973	1.8 for 1975 0.85
	school districts in Minnesota, 1972 and 1976	per pupil total expenditure	per pupil state block grant for education	0.41 for 1972
		change in per pupil total expenditure between 1976 and 1972	change in per pupil state block grant for education between 1976 and 1972	0.28 for 1976 0.49
		per pupil total expenditure	per pupil state education categorical grant	1.33 for 1972
		change in per pupil total expenditure between 1976 and 1972	change in per pupil state education categorical grant between 1976 and 1972	1.07 for 1976 0.80

determinants of the per pupil educational expenditures in 1,127 school districts in 23 states. Taking into account factors relevant to the demand for education (e.g., percent school-aged children in the population of a school district), the supply of education (e.g., salary of teachers), and variables reflecting the legal difference among districts in various states (e.g., types of grants, state education as a proportion of total educational expenditure), Miner constructed a single-equation model relating per pupil total educational expenditure to more than a dozen independent variables. He found that per pupil total educational expenditure was negatively related to state education aid as a proportion of total educational expenditure. This result is consistent with the fact that poorer districts have lower levels of educational expenditure though they receive relatively more aid than wealthier districts.

Later studies have concentrated on analyzing interstate school district spending behavior. While the studies discussed so far have used total educational expenditure as the dependent variable, some of the studies in Table 2-1 have turned to other dependent variables such as locally financed educational expenditure and local school tax. Struyk (1970) studied the effects of state aid on the provision of education and welfare services of 140 school districts in New Jersey. His approach was to modify Gramlich's (1968) model to specify state aid as an endogenous variable, so as to take into account the possible joint determination of state aid and local expenditure. Using a TSLS technique and data for 1965-1966 school year, he found that for every additional dollar of state aid to education, a school district in New Jersey seemed to increase its educational spending by 65 cents.

Stern (1973) analyzed the spending behavior of 157 school districts in Massachusetts using 1968-1969 data. Assuming that local school authorities will show some consistency in

evaluating different combinations of local tax rates and educational expenditure when the state aid formula changes, he specified a preference function for local school boards including sociodemographic factors, school tax rate, and locally financed educational expenditure.

Assuming that a school board will maximize its preference function with respect to the single control variable of locally financed educational expenditure, Stern derived an equation relating locally financed educational expenditure to a number of explanatory variables including state block grants for education, community income, and other sociodemographic factors.

Regression analysis indicates that for every additional dollar of state education block grant received, a school board will reduce locally financed educational expenditure by 45 to 55 cents. In other words, total educational expenditure will increase by 45 to 55 cents.⁷ Having estimated the parameters in the preference function, Stern subsequently used the function to simulate the effects of a power equalization formula. He found that power equalization grants would reduce the disparities in educational expenditures among school districts due to property value differences associated with socioeconomic status.

Grubb and Michelson (1974) also studied the educational expenditures of Massachusetts school districts. In their study, they applied several models (a utility function specification, a linear additive specification, a log-linear specification, and a linear expenditure function) of spending behavior of school districts, and found that the results differed significantly among the models. For unrestricted education block grants, they found that locally financed educational expenditure would decrease by an amount between 19 cents and \$1.18 for every additional dollar of such grants. The elasticity of locally financed educational expenditure with respect to the price of education services ranged between 0.14 and 1.2.

When a linear, additive relationship between locally financed educational expenditure and a number of explanatory variables was used, they found that for every additional dollar of state education block grants received, locally financed educational expenditure would decrease by 74 cents, which means that total educational expenditure increases by 26 cents. The effect of state education categorical grants, however, was found to be stimulative. Locally financed educational expenditure would increase by \$1.21 for every additional dollar of state education categorical grants. They also found that the elasticity of locally financed educational expenditure with respect to the price of education services was 0.5, but was not significant statistically.

Feldstein (1975) and Ladd (1975) also studied the Massachusetts school districts. Feldstein specified a log-linear relationship between total educational expenditure and a number of explanatory variables including state educational block grants, property wealth, price of education service, and others. For various forms of the log-linear expenditure function and different sets of data, he found that the elasticity of total educational expenditure with respect to the price of education service ranged from -1.6 to -0.94. For the 1970 cross-sectional data, the estimated price elasticity was -1.0; the elasticity of total educational expenditure with respect to the state block grant was 0.066, which corresponded to a marginal propensity to consume such funds of approximately 0.6. But he pointed out that 0.6 would be biased upward, because in 1970 most block grants were paid to towns that passed the limit of matching aid, so that block grants were endogenous.

Feldstein was concerned with how to finance local education to neutralize the effects of differences in local wealth without sacrificing local choice. He developed a theoretical

model to produce a means of achieving “wealth neutrality,” that is, a condition whereby per pupil educational expenditure of a district is not related to a measure of local wealth that emphasizes property value, income, and other aspects of community wealth. This involves selecting the proper matching rate parameter so that the elasticity of total educational expenditure with respect to wealth is zero. His analysis of the educational expenditure of Massachusetts towns and communities suggests that matching grants may be used towards achieving wealth neutrality.

Ladd (1975) analyzed the 1970 data for 78 communities in the Boston SMSA. Using a log-linear equation relating total educational expenditure and a number of explanatory variables, she found that the estimated price elasticity associated with state matching grants for education ranged between -0.65 and -0.49. The elasticity for state education block grants was around 0.03, and the elasticity for total intergovernmental education categorical aid (state plus federal categorical aid for education) was 0.11 (the implied marginal propensities to spend were 0.5 and 1.1, respectively). Ladd’s emphasis in the study was to show that the composition of the property tax base would affect local decisions to provide educational services. She found that a district with a higher proportion of residential property (thus a lower proportion of commercial and industrial property) would tend to spend less on education. The tendency of a highly residential community to spend less may be because residential taxpayer voters will share a larger portion of the tax burden for additional spending than in a community whose tax base is much more heavily commercial and industrial. She also found that commercial property had more strongly positive effect than industrial property on educational expenditure.

The substitutive-stimulative effect of state aid on the educational expenditures of school districts is supported further by Cohn (1974) and Bowman (1974). Cohn focused his attention on 67 counties in Pennsylvania and used a model developed by Clyde (1973). The Clyde model consists of a system of simultaneous equations relating four endogenous variables to a number of exogenous variables (one of them being the state education grant). One of the endogenous variables was per pupil locally financed expenditure. Using the TSLS procedure, Cohn found that for every additional dollar of state education grants received, a county will reduce its own educational expenditure by 12 cents. In other words, total educational expenditure will increase by 88 cents. He pointed out that the result indicated a higher stimulative effect for state education grants in this intrastate study than that found in his interstate study (see Table 2-1). He noted that, while the majority of the states in the country use foundation grants, Pennsylvania is one of the few states that use a percentage equalization grant scheme. He suggested, though he could not prove, that the latter scheme might be more stimulative than the former scheme.

In studying the effect of state education grants on educational expenditures, Bowman (1974) approached the problem from another direction. Instead of finding the change in educational expenditure per dollar of state education aid, he considered the relation between state education aid and the amount of school tax raised to fund education. He found that for every additional dollar of state education aid received, a school district will lower its tax by 50 cents. His result supports the commonly held view that a local government will use part of the state aid to reduce its taxes.

Black, Lewis and Link (1979), and Grubb and Osman (1977) both considered the impact of state education block grants on the total educational expenditure of school districts. Black et al. analyzed pooled data for the 23 regular school districts in Delaware. The study shows that a Delaware school district will increase total educational expenditure by 77 cents per additional dollar of state education block grants received. This result is quite close to that of Grubb and Osman, who found a coefficient of 78 cents per dollar of state aid for California unified school districts.

The study by Park and Carroll (1979) of 451 school districts in Michigan, however, indicates a much lower response of school districts to state education aid. They found that a Michigan school district would increase its total educational expenditure by only 6 cents and 32 cents per additional dollar of state education block grants and state education categorical grants received, respectively. For state education matching grants, their estimate of price elasticity was -0.02, much smaller than those estimated by Feldstein and Ladd. Such a low price elasticity implies that a matching grant will not be stimulative.

Vincent and Adams (1978) investigated the fiscal response of school districts in two states, Colorado and Minnesota using 1973 and 1975 data for Colorado and 1972 and 1976 data for Minnesota. They carried out a one-year, cross-sectional study, as well as an analysis for each state explaining changes between the two years of each data set. For Minnesota, they found that total educational expenditure per pupil would increase by 41 cents and 28 cents for each additional dollar of state education block grants received in 1972 and 1976, respectively. This implies that Minnesota school districts on the average used an extra dollar of state education block grants to reduce local taxes by 59 cents and 72 cents in 1972 and 1976,

respectively. In the change analysis, they related changes in total educational expenditures between the two years to changes in the explanatory variables over that period. They found that school districts would spend an additional 49 cents for every additional dollar of state education block grant received. This suggested that the property tax reduction impact may be somewhat lower over time than the impact that could be inferred from the one-year, cross-sectional analysis. As for state categorical grants for education, the coefficient was 1.33 for 1972 and 1.07 for 1976. The change analysis yielded a coefficient of 0.80, indicating that some substitution over time of state educational categorical aid for local property taxes may be indicated by the cross-sectional analysis. Similarly, for Colorado school districts, the coefficient for state categorical grants for education was 1.6 and 1.8 for 1973 and 1975, respectively. The analysis for changes between 1973 and 1975 yielded a coefficient of 0.85.

Adams (1979, 1980) continued her study of the fiscal responses of school districts in several other states. In her 1979 study, she found that the estimated elasticities of total educational expenditure with respect to the price of education service was quite small compared to those reported by Feldstein and Ladd, but closer to the results of Park and Carroll. For school districts in Colorado, the estimated price elasticity ranged between -0.09 and -0.08; for Wisconsin school districts, it was between -0.22 and -0.19. For state education categorical grants, the estimated marginal propensity to spend was 0.17 for Colorado, 0.5 for Kansas, 0.7 for Maryland, and close to 1.7 for Wisconsin. The estimated marginal propensity to spend out of foundation grants was in the range 0.6 and 0.7 for school districts in Maryland between 1972 and 1976.

She also found out that other components of a school aid structure, such as the nature and scope of spending limitation, and/or the differential treatment of districts on the basis of size or other criteria, could affect the impact of a state education grant. She cited the results for Colorado and Wisconsin, two reform states that have adopted equalization reforms in educational finance which use a Guaranteed Tax Base Formula (GTB).

In her 1980 study of New York state school districts, Adams found that, on average, total educational expenditure would increase by 59 cents for each additional dollar of state education block grants received, and by \$1.06 for each additional dollar of state categorical grants awarded by the state government. However, she found that the marginal propensity to spend out of a state education block grant differs between upstate school districts (0.68) and downstate school districts (0.05). The results also indicate that downstate school districts tend to spend more out of additional dollars of personal income for education services than upstate school districts. This suggests that the individual characteristics of school districts affect the fiscal response to state aid, and any statistical analysis of average behavior may differ significantly from individual district behavior. She also considered two other issues: prices of school inputs and effects of noneducation services on educational expenditures. Since the prices of school inputs vary among school districts, nominal educational expenditure may not reflect the real level of education services provided. Using an index of the variation of input prices for New York school districts developed by Wendling (1980), she adjusted nominal total educational expenditure into "real" total educational expenditure. She found that the analysis of nominal total educational expenditure indicated that a percent increase in general state aid would increase nominal total educational expenditure by 0.07 percent. However,

when total educational expenditure was analyzed in real dollars, the response measure was lower, only 0.04 percent. She also found that total educational expenditure was positively related to expenditure on noneducation services.

Perkins (1984) studied the Massachusetts school districts. Following Feldstein's (1975) log-linear expenditure equation, total educational expenditure was related to property wealth, price of education service, state block grant, and other variables which reflect community resources and characteristics. He found that both elasticities of total educational expenditure with respect to the price of education service and with respect to state block grant were lower than Feldstein's. For the 1970 cross-section data of 112 communities, the estimated price elasticity was -0.70, and the elasticity of state block grants was 0.013. For the pooled data of 307 communities for 1970, 1973, 1975, and 1976, the price elasticity was -0.65 for OLS and -0.56 for a fixed-coefficient or dummy variable model. The elasticity of state block grant was 0.01 for both models. Thus, the price elasticity estimates were inelastic. Income elasticity was also everywhere inelastic, ranging from 0.411 to 0.832. Hence, he challenged the Feldstein's argument that complete wealth neutrality can be achieved with matching grants that involve a relatively low elasticity of price with respect to wealth. He derived the wealth neutrality measure, and concluded that the elastic response to price movements suggest that the grant scheme proposed by Feldstein could not effectively neutralize the influence of wealth in local education spending. Moreover, he said the large variations across communities in matching rates required by Feldstein's policy suggest substantial price distortions that in turn may increase economic inefficiency.

Megdal (1984) analyzed the pooled data of 1970, 1974, and 1977 for 177 school districts in New Jersey. She used a log-linear median voter model relating total current expenditure less tuition revenue to median income, price of education service, total state and federal categorical aid, state block aid, equalized residential value as a wealth variable, enrollment increase, and other variables that represent community characteristics. Using OLS, she found that the estimated price elasticity associated with state matching aid was -0.28, which is very inelastic. She suggested that a program of matching grants would have to result in a sizable decrease in the perceived price of education if it is to produce an even modest increase in expenditures. Hence, she concluded that a program of matching grants might not be successful in stimulating expenditures in order to meet equity goals in school finance. The elasticity of total expenditure with respect to state block grants for the pooled sample was -0.06, which is statistically significant. This was an unintuitive result, but she suggested that there could be uncertainty as to the future aid situation, since there had been a transition period for the aid formula and it was doubtful that the current aid formula would remain in effect. Therefore, districts might have resisted increasing spending in response to aid revenues so as to avoid large future tax increase should the aid formula change significantly.

Addonizio (1991) recently studied 345 school districts in Michigan for the 1982-1983 school year. He used weighted least squares to estimate total expenditure as a function of price of education service, median income, state block grant, federal block grant, percentage of private school enrollment, an index of teacher salaries, and other variables. Since the state of Michigan provided the Guaranteed Tax Base (GTB) school-aid formula and adopted a Homestead Property Tax Credit program, known as a "circuit breaker," he proposed four

different tax price equations. The estimated price elasticity ranged -0.09 to -0.01 for in-formula districts and -0.24 to -0.36 for out-of-formula districts. He showed that after adjusting for circuit breaker income tax credits, the price effects of the GTB formula are more than offset by the countering effects of the circuit breaker and the disparities in local property wealth. He found that an additional dollar of state education block grants was very stimulative and would increase total educational expenditure of in-formula school districts by \$2.28 to \$2.36, depending on the price equations, whereas for out-of-formula districts it was not statistically significant at all. This result differed substantially compared to Park and Carroll (1979), who showed a not-so-stimulative result, but he cautioned that this should not be interpreted as proof that such grants would succeed in stimulating low-spending districts if used more extensively.

b. Federal grants and educational expenditure

Though federal involvement in education has been increasing since the passage of the 1965 Elementary and Secondary School Act, its significance has been relatively modest compared to state and local involvement. Most of the federal grants for education take the form of categorical grants targeted for specialized education programs. The largest grant has been provided by Title 1 of the Elementary and Secondary School Act of 1965, which provides compensatory education for children from low-income families. Open-end matching education grants have not been used commonly by the federal government.

A number of studies on federal grants for education are reviewed here. They are divided into two groups and are presented in Table 2-2 and Table 2-3. Table 2-2 consists of

studies that used data before 1966, a period in which federal involvement in education was minimal. Table 2-3 consists of the studies that have used data after 1965. Because grants to Title 1 programs constitute a large portion of federal education aid to state and local governments, some of the studies in Table 2-3 have chosen to divide federal education aid into two parts: Title 1 grants, and non-Title 1 federal education grants. The effects of these two parts of aid are considered separately. The estimates presented in these two tables are statistically significant at the 5% level unless stated otherwise.

Another type of federal grant to state and local governments that will affect educational spending is general revenue sharing (GRS). However, as mentioned earlier, it should not be viewed as a system of grants to support any particular public service like education. The specific effects of revenue sharing on educational spending depend crucially on the relative preferences of state and local governments receiving GRS grants for using additional revenues on education as opposed to other public goods. Thus, studies of the impact of revenue sharing are not presented here.⁸

First, consider the studies in Table 2-2. Osman (1966) obtained a large and statistically significant coefficient for federal education grants (the 5.11 marginal propensity). In his cross-sectional study, he argued that federal grants to other noneducation functions also would affect educational expenditures because funds from these federally-aided, noneducation functions might be released for use in education. Thus, in his one-equation model, total educational expenditure was made a function of per capita income, number of students attending local public schools per 1,000 of state population, federal grants for education, as well as federal grants to noneducation functions. He found that the effects of noneducation

Table 2-2. Empirical studies of the impact of federal aid on state and local educational expenditures, studies using data before 1966

Study	Data (cross-sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant, G)	Response (marginal change, dE/dG)
Booms & Hu (1971)	50 states, 1960	per capita total state-local expenditure	per capita federal aid	1.68
O'Brien (1971)	48 states, 1958-1966 (pooled data)	per capita state-local expenditure from own funds	per capita federal education aid	0.67
Osman (1966)	48 states, 1960	per capita total expenditure of state	per capita federal education aid	5.1
Pidot (1969)	81 largest SMSAs in 1962	per capita SMSA total expenditure	per capita federal aid	0.13, insignificant
Pogue & Sgontz (1968)	48 states, 1958-1964 (pooled data)	per capita total expenditure for local education	per capita federal education aid	-0.25 to 1.72
		per capita total expenditure for all levels of education	per capita federal education aid	3.0 to 4.9
Smith (1968)	50 states, 1965	per capita state-local expenditure own funds	per capita federal education aid	0.69, insignificant

federal grants on total educational expenditure was statistically significant, and the coefficient was positive.

Pogue and Sgontz (1968) questioned Osman's finding that federal grants were purely stimulative. In their study, they analyzed expenditure for all levels of education and expenditure of local schools in 48 states for a period of 7 years, 1958-1964. The impact of federal education grants was found to be different for these two kinds of expenditure. For local school expenditure, the coefficients for federal education grants for the 7 years were, respectively, -0.25, 1.22, 1.23, 1.17, 0.10, 1.18, and 1.72. None of these coefficients was statistically greater than 1.0. Thus federal education grants are not necessarily purely stimulative. For expenditure on all levels of education, the coefficients for federal education grants for the 7-year period were 3.83, 4.92, 4.19, 4.61, 2.99, 3.36, and 4.33. All except the first value (3.83) were greater statistically than 1.0 at the 5 percent level. The fluctuating values of the coefficients for federal education grants indicate that state and local governments may not be in a state of budgetary equilibrium; they may reflect a process of frequent budgetary adjustment. Thus, it is unwarranted to claim that the result of a cross-sectional analysis on a given year is applicable to an extended period of time in assessing the impact of federal grants.

In his cross-sectional analysis, Smith (1968) found that each additional dollar of federal education aid was associated with an increase of \$1.69 in total educational expenditure. However, the estimate was not different statistically from 1.0. In contrast, Pidot (1969) found that the effect of federal grants was substitutive-stimulative, but statistically not significantly different from zero. His estimated coefficient was 0.13.

The later studies by Booms and Hu (1971), and O'Brien (1971), however, provide some evidence that federal grants may be purely stimulative. In their study, Booms and Hu formulated a simultaneous equation model to distinguish demand aspects from supply aspects in an attempt to identify and thus measure the determinants affecting the demand for and supply of education. Using the TSLS procedure, they obtained a value of 1.68 for the marginal propensity to spend out of federal education grants.

O'Brien investigated the simultaneous determination of grants and expenditures, the question of whether federal funds stimulate or substitute for state-local expenditures, and the effect of individual state characteristics on statistical estimates. Using a pooled data sample of 48 states and different estimation techniques (OLS, TSLS, and GLS), he concluded that grants and expenditures were not determined simultaneously, that federal grants would stimulate state-local expenditures of their own funds on aided categories and cause expenditure reduction on unaided categories, and that the effect of individual state characteristics was important. One estimate suggested that each additional dollar of federal education aid will stimulate an additional 67 cents from the government receiving aid.

Table 2-3 shows the studies for the post-1965 period. Most of these studies have been mentioned in the proceeding section under state grants and educational expenditure. Grubb and Michelson (1974) have found a significant and very stimulative effect of Title 1 federal grants on the education expenditures of 159 school districts in Massachusetts. They estimated that for each additional dollar of Title 1 aid received, a Massachusetts school district will, on average, raise its own educational expenditure by \$4.4, that is, total educational expenditure will increase by \$5.4 for each additional dollar of Title 1 aid. As for non-Title 1 aid, the effect

Table 2-3. Empirical studies of the impact of federal grants on state and local educational expenditures, studies using data after 1965

Study	Data (cross sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant, G)	Response (marginal change, dE/dG)
Adams (1979)	school districts in Maryland, 1972-1976 (pooled data)	per pupil total expenditure	per pupil federal education categorical grant	1.05 to 1.18 (elasticity = 0.118)
	school districts in Wisconsin, 1973-1974 and 1975-1976 (pooled data)	per pupil total expenditure	per pupil federal education categorical grant	0.65 for both periods (elasticity = 0.022)
Addonizio (1991)	345 school districts in Michigan, 1982-1983	per pupil total expenditure	per pupil federal education block grant	between 1.70 and 1.80 for in-formula between 0.70 and 1.29 for out-of-formula
Craig & Inman (1982)	48 states, 1965-1977 (pooled data)	state education aid to local educational authorities	federal pass-through education aid	0.32
			federal pass-by education aid	-1.55
			federal matching education aid	-1.37
Feldstein (1978)	4690 school districts across country, 1970	per pupil total expenditure	per pupil federal Title I grant	0.72
			per pupil other federal education grant	0.41

Table 2-3. (Continued)

Study	Data (cross sectional unless stated otherwise)	Dependent variable (educational expenditure, E)	Independent variable (grant,G)	Response (marginal change, dE/dG)
Grubb & Michelson (1974)	159 school districts in Massachusetts, 1968-1969	per pupil locally financed expenditure	per pupil federal Title 1 grant	4.4
			per pupil other federal education grant	-0.5
Ladd (1975)	78 communities in Massachusetts, 1970	per pupil total expenditure	per pupil state and federal education aid	1.1 (elasticity = 0.11)
Megdal (1984)	177 school districts in New Jersey, 1970, 1974 and 1977 (pooled data)	per pupil total expenditure less tuition revenue	per pupil state and federal categorical education aid	1.45 for 1970 1.13 to 2.46 for 1974 1.75 for 1977
Park & Carroll (1979)	451 school districts in Michigan, 1971-1976	per pupil total expenditure	per pupil federal education categorical grant	0.38 (elasticity=0.02)
Vincent & Adams (1978)	school districts in Colorado, 1973 and 1975	per pupil total expenditure	per pupil federal education aid	1.6 for 1973 0.87 for 1975
		change in per pupil total expenditure between 1975 and 1973	change in per pupil federal education aid between 1975 and 1973	1.46
	school districts in Minnesota, 1972 and 1976	per pupil total expenditure	per pupil federal education aid	1.3 for 1972 0.89 for 1976
		change in per pupil total expenditure between 1976 and 1972	change in per pupil federal education aid between 1976 and 1972	0.81

is substitutive-stimulative. Total educational expenditure will increase by 50 cents for each additional dollar of non-Title 1 federal education aid.

The result of Feldstein's (1978) study on Title 1 federal aid was in sharp contrast to that of Grubb and Michelson. Feldstein analyzed the total educational expenditures of 4,690 school district across the country. Using 1970 data, he found that Title 1 federal aid had a significant but substitutive-stimulative effect on the total educational expenditure of a school district. For every additional dollar of Title 1 federal aid received, a school district will increase its total educational expenditure by 72 cents. As for non-Title 1 federal education aid, he found that a school district will raise its total educational expenditure by 41 cents for each additional dollar of such aid, a result comparable to that of Grubb and Michelson. A number of other studies also have considered the effect of federal categorical grants on total educational expenditure. Most of them yielded a value close to 1.0 for the marginal propensity to spend out of federal educational categorical grants.

Ladd (1975) found that a Massachusetts school district will tend to increase total educational expenditure by \$1.10 for each additional dollar of federal educational categorical grants.⁹ Vincent and Adams (1978) have estimated for Colorado school districts that the marginal increase in total educational expenditure was 1.6 for the 1973 data, 0.87 for the 1975 data, and 1.46 for the change analysis using changes in data between 1973 and 1975. They also found that the marginal increase in the total educational expenditure of Minnesota school districts was 1.3 in 1972, 0.89 in 1976, and 0.81 from the change analysis between the two years. Adams (1979) found a value between 1.05 and 1.18 for Maryland school districts and 0.65 for Wisconsin school districts. Park and Carroll's (1979) study of Michigan school

districts showed 38 cents of marginal spending out of each dollar of federal aid, which was a substantially lower marginal increase in total educational expenditure.

Craig and Inman (1982) studied the impacts of different types of federal grants on the amount of state education aid to local educational authorities (LEAs). They constructed models for the fiscal behavior of both state and local governments. The model for a state government consisted of state-aid equation, a tax equation, and a budget constraint. The model for a local government was comprised of equations for each of the major components of local expenditure, a tax equation, and a budget constraint. Using pooled data for 48 contiguous states and the generalized least squares technique, they found different effects for different types of federal grants. The effects were statistically significant for pass-through federal education aid (PTEA, categorical education aid such as Title 1 that is given to the states with the requirement that such assistance be passed through to the LEAs for spending on schooling with no reduction in current state education aid), by-pass federal education aid (BPEA, categorical education aid given directly to LEAs, thereby “by-passing” the states), and federal matching education aid (MEA, categorical education aid requiring a limited match by state and local governments); but a fourth type of federal grant, an unconstrained general-purpose aid given to state and/or LEAs (GRS), was found to be statistically insignificant. An additional dollar of PTEA was found to stimulate an additional 32 cents of state education aid to LEAs, but the estimates showed a state reduction in aid to LEAs of \$1.55 and \$1.37 for every additional dollar of BPEA and every additional dollar of MEA, respectively. Using their models and estimates, they found that each additional dollar of PTEA was associated with an

increase of 73 cents in local school expenditures, but each additional dollar of BPEA led to a reduction of 25 cents in local school expenditures.

Megdal (1984) found that the elasticity relating total expenditure to total state and federal categorical grants was 0.05. This implied that districts increase spending by more than a dollar in response to receipts of a dollar of categorical aid, ranging \$1.45 for 1970, \$1.13 or \$2.46 for 1974, depending on school districts, and \$1.75 for 1977. Addonizio (1991) found that in the state of Michigan the school districts would increase total educational expenditure by \$1.70 - \$1.80 for school districts where the GTB formula was effective and by \$0.70 - \$1.29 for school districts where the GTB formula was not effective, for each additional dollar of federal educational block grant.

c. A synthesis

The above review of the studies, which focused on the impacts of intergovernmental grants on educational expenditure, cover two levels of intergovernmental grants: federal grants to state and local governments, and state grants to local governments. Although there are differences among them with regard to the method of analysis used and the units of governments examined, the findings of these studies do lend themselves to some generalization about the responses of state and local governments to intergovernmental grants. In general, these studies have found significant effects of intergovernmental grants and a few socioeconomic and demographic factors such as property wealth, personal income, population density, age distribution, and the composition of local tax base on the level of educational expenditures of local governments.

Most studies of unrestricted state block grants for education (or general state equalization aid in the form of foundation grants and/or flat grants) indicate that the effect of such grants on the total educational expenditure of a local government is substitutive-stimulative. A local government receiving such a grant will typically use part of the grant for educational services; thus in this aspect, the impact of grant is stimulative. The local government, however, will use part of the grant on noneducational activities. It may use some of the state aid for other government functions or it may use it to reduce the local tax burden; in this respect, the state block grant is substitute for local expenditure. The marginal propensity to spend block grants for education reported in the empirical studies ranges from a low of 0.16 to a high of 1.06. However, most values do lie within the smaller range 0.3 to 0.7. An approximate estimate for the marginal increase in total educational expenditure per additional dollar of unrestricted state block grants for education is 50 cents.

For the few states that have employed some form of matching grants for education, which lower the price of education services for a local government, empirical studies have found a negative relationship between total educational expenditure and the price education services. However, the estimated price elasticity implies that the response of a local government is either quite responsive or not responsive at all. The estimated price elasticity is -1.0 for Feldstein's (1975) study of Massachusetts, -0.65 to -0.49 for Ladd's (1975) study of Massachusetts, -0.02 for Park and Carroll's (1979) study of Michigan, and -0.09 to -0.08 for Adam's (1979) study of Colorado. Thus, the precise impact of a state matching grant for education seems to depend critically on the characteristics of a local government receiving the

grant, and it is not recommended to generalize the experience of school districts in one state to school districts in another state.

The state categorical grant for education is substitutive-stimulative for some school districts, but purely stimulative for other school districts. The estimated coefficients range from 0.17 to 1.8, but a number of later studies have indicated that for each additional dollar of state categorical grants for education, total educational expenditure will increase by an amount that is close to one dollar indicating that there is little stimulation of locally financed educational expenditure. On average, state categorical grants for education appear to be more stimulative than state unrestricted block grants for education. This may be due to the fact that a categorical grant usually has more strings and requirements attached to it than an unrestricted block grant, so that the government receiving the grant is induced to spend more on the categorical program per dollar of aid.

Since federal involvement in education became more substantial only after 1965, a current focus relies more heavily on the studies that analyze the responses of state and local governments to federal aid after 1965. Among the studies discussed previously on federal categorical grants for education, the most extensive is that by Feldstein (1978). This research indicates that for each additional dollar of federal categorical grant for education, there is an increase of 72 cents in local educational expenditure; a similar estimate (73 cents) is provided by Craig and Inman (1982). Other studies (Ladd 1975, Vincent and Adams 1978, Adams 1979), however, have found that the increase in local educational expenditure was as high as one dollar or even more. Based on these studies, one may conclude that an additional dollar of

a federal categorical grant for education is associated with an increase of 70 cents to one dollar of local educational expenditure.

With regard to federal matching grants for education, there is not much work reported in the literature because the federal government has seldom used matching grants for education. A study by Craig and Inman (1982) has indicated that a state will reduce its aid to local governments that receive aid from the federal government. The impact of a federal matching grant thus may be less stimulating than a state matching grant.

Although the link between intergovernmental grants and the level of educational expenditures has been established firmly, the exact magnitude of the relationship between them varies from study to study. This is hardly surprising when one recognizes the different samples, time periods, and analytical approaches that have been used. One can see from the previous discussion that the coefficient for intergovernmental grants can be different between cross-sectional studies and time series studies for the same entities. Also, the estimates appear to change according to the formulation of the statistical model. Moreover, for the same set of government units examined and the same model formulation used, a cross-sectional analysis often yields different values for the coefficient for intergovernmental grants when different time periods are considered. Furthermore, the impact of intergovernmental grants on educational expenditure is different for different groups of governmental units. These different results illustrate some of the conceptual and statistical problems in the empirical estimation of the effects of intergovernmental grants on educational expenditures, and one should be aware of them in interpreting the findings of these empirical studies.

Notes

1. Earlier reviews of the impact of intergovernmental grants on educational expenditure include Cohn (1974), Vogel (1982), and Tsang and Levin (1982).
2. Other subcategories usually include welfare, highway construction, and public safety. There are many studies in the empirical literature on the impact of intergovernmental grants on total public expenditure as well as on several categories of non-educational expenditures of state-local governments. They are not discussed here since they do not relate directly to educational expenditures. For a review of these studies, see Gramlich (1977).
3. For a concise comparison of time series and cross-sectional studies, see Gramlich (1969).
4. Most studies reviewed here have used total educational expenditure (per capita or per pupil) as the dependent variable. The studies by Smith (1968), Stern (1973), Cohn (1974), and Grubb and Michelson (1974) used locally-financed educational expenditure (per capita or per pupil) as the dependent variable. Total educational expenditure is equal to locally-financed educational expenditure plus intergovernmental aid. Bowman (1974) used school tax per pupil as the dependent variable while Craig and Inman (1982) is the only one reviewed here that used state education aid as the dependent variable.
5. See Atkinson and Stiglitz (1978 pp. 316-321) for more details.
6. Denzau (1975) tried to evaluate competing local education expenditure function specifications. He estimated several determinants specifications on a single data set and used t , F , and R^2 statistics of each to assess its relative performance. He found that the sign of parameters and their significance generally are robust with respect to specification.
7. Since total educational expenditure is equal to locally financed educational expenditure plus intergovernmental aid, it can be shown readily that the coefficient for the intergovernmental aid variable of the regression using total educational expenditure as the dependent variable is equal to one plus the coefficient of the intergovernmental aid variable of the regression using locally financed educational expenditure as the dependent variable, *ceteris paribus*.
8. The empirical studies related to general revenue sharing and federal unrestricted lump sum aid to state governments are Gramlich (1968), Inman (1971), Gramlich and Galpher (1973), Nathan et al. (1975), Juster (1976), and Nathan and Adams (1977).
9. To be exact, the response is \$1.10 for each additional dollar of total intergovernmental categorical aid (state plus federal categorical aid).

CHAPTER III. THE CHOICE PROBLEM

A. The Median Voter Model

Perhaps the most prominent specification of local fiscal choice is the median voter model. The basic specification of spatial (competition) politics finds its intellectual start in Hotelling (1929). Bowen (1943) developed and extended the framework to problems of budgetary choice in a referendum setting, and Downs (1957) overlaid the needed institutional analysis under representative democracy, which enriched the model conceptually. Black (1958) explained Bowen's idea in great detail and developed the model for committee type majority rule decisions. Bradford and Oates (1971) applied it to policy, and Barr and Davis (1966), Borcherting and Deacon (1972), and Bergstrom and Goodman (1973) used it as a formal basis for econometric analysis. In its simplest and empirically most usable form, the median voter model hypothesizes¹ (i) a given tax schedule and a single public service for which (ii) consumer-voters have single-peaked preferences. Voters are (iii) sincere voters - i.e., vote their preferences, and not strategically, and can be ordered along a continuum from low to high demanders of the public service. The result is a distribution of votes by these preferred levels of the public service. The assumed constitutional rule for local fiscal choice is (iv) to select the service level that will defeat all others in a majority rule election. Under assumptions (i)-(iv), the preferred level of local services will be the median of the distribution of the demanded quantities. To identify the crucial median service quantity and apply the model empirically, it is assumed (v) that the quantity is that demanded by the consumer-voter

with median income. Given assumptions (i)-(v), governments will select their budgetary levels 'as if' to maximize the well-being of each jurisdiction's median income family. The individual utility maximization model, then, is applied to the median income family to analyze governmental fiscal performances. Thus, this hypothesis give a rather powerful starting point for predictive and normative analysis of government behavior.

While the median voter model has been well-accepted in public economics from the early 1970s, there have been serious challenges and criticism since then. The first one was Niskanen's (1971) portrayal of budget maximizing bureaucracy. He explicitly used the median voter model as the foundation of the demand side of his model. His innovation was building a supply side of the market and matching it to the median voter model of demand in order to develop a complete supply and demand model of public sector. His conclusions were at odds with the conclusion generally accepted as being implied in the median voter model that the public sector produced what the median voter wanted.

The next one was to build Niskanen's budget maximization hypothesis directly into the voting models themselves. Romer and Rosenthal (1978, 1979a, 1979b, 1982) extensively examined the agenda control model. The agenda control model uses a referendum process much like Bowen described, but illustrates that a budget maximizing agenda setter can manipulate the alternatives in such a manner as to produce an outcome larger than would be most preferred by the median voter. In their model, however, the referendum acts as a constraint on the agenda setter, and, since most public sector spending decisions are made without approval via referendum, it leaves open the more important question of what constrains the size of the budget in the more typical case when a referendum is not held.²

The most devastating blow to the median voter model was dealt by McKelvey (1976). He used a model similar to Black's, where single-peaked preferences and sequential motions by majority rules are assumed, but he expanded the model so that political issues are multidimensional rather than single dimensional. He illustrated that an agenda setter could start at any point in the issue space and by strategically selecting issues end up at any other point in the issue space, so that there is no unique and stable majority rule outcome. But Tullock (1982) asked how the public sector could appear so stable in the face of the formal proof of instability.

The median voter model, as a public sector demand, should not be expected to show a full public sector equilibrium. The median voter model is simply a model of demand aggregation, so that the model depicts the market demand when aggregated by the majority rule to be the demand of the median voter. The great advantage of the median voter paradigm is that it allows one to analyze social problems via the preferences of a single individual, the pivotal median voter. The arguments taken to discredit the median voter model as a general description of majority rule electoral outcomes do so only by showing that in theory there are many conditions that could cause the model's assumptions to be unrealistic. Most of the empirical evidence published regarding the median voter model is consistent with the model.³ Though the empirical evidence never provides irrefutable proof, since it can be consistent or inconsistent with a hypothesis, the evidence by itself would suggest that the model is more than just a special case that is rarely applicable to the real world.

However, the theoretical and empirical evidence does not imply that the public sector produces what the median voter wants. This claim is stronger than the model warrants.

Rather, the evidence suggests that the median voter model is a good description of how demands are aggregated under majority rule in many circumstances. Pointing out that the model might not be valid under some circumstances in no way implies that the model is never valid. The median voter model provides a benchmark in that it describes a unique and stable majority rule equilibrium so that theorists can demonstrate how easy it is to develop plausible conditions under which the model's conclusion will not hold. Therefore, the median voter model is to provide a base for the development of a theory of political structure that is analogous to the theory of market structure in economics.

The median voter hypothesis will be maintained throughout this study. In addition to the ample empirical evidences, the median voter model of expenditures of local governments (particularly in federal systems) might reasonably be expected to provide a fertile ground for empirical testing with the following reasons. First, expenditures are directly quantifiable so that 'objective' measurements of alternatives and policy outcomes are possible. Secondly, local populations tend to be more homogeneous than the population of the country as a whole. Thirdly, the largest local expenditure is for *education*. Since most school boards are independent taxation and expenditure authorities, they deal with expenditure in only one area. This leads to an important element of the unidimensionality.⁴

B. Empirical Specification Problems

Empirical studies of the demand for public education and the impact of intergovernmental grants have encountered some specification problems due to the peculiar

nature of the good. One problem is to define the good in a measurable way since it is not observable directly like most private goods. The early local expenditure determinants studies simply concentrated on total expenditures. Since none of them were based on any solid theoretical foundation, the issue of output definition and measurement was not important. As studies turned to voting models and other community decision frameworks to generate public demand functions, this problem has been confronted. The most common approach has been to define local education services as a single good, measuring it by expenditures or other criteria such as standardized test scores. Measuring education by expenditures has the obvious drawback in that it does not take into account resource cost differences across jurisdictions. Deflating expenditures by an input price index, if any, may not solve the problems. As Leekely (1980) regards local public education as a category of multiple outputs such as the mastery of cognitive, social, vocational skills, and positive attitudes, the serious question about education as a single good might be raised. He recognizes that this package need not be identical across communities. Then, the multiple output approach was suggested. However, his approach brings us no closer to resolving measurement problems. This study just follows convention and pursues the single-output approach for measuring the impact of aid to education expenditure.

Though the measurable definition is determined, a measure of individual consumption must be devised to make the representative voter demand framework operational since education exhibits a certain degree of publicness in consumption. Both Borcharding and Deacon (1972) and Bergstrom and Goodman (1973) show a rather simple way of capturing this congestion phenomenon.⁵ Borcharding and Deacon demonstrate that the same principles

applied in private goods demand studies could be used in public goods demand studies since the relationship between individual consumption and community consumption is specified.

Another problem in educational aid studies is that several aid programs exist simultaneously. The complexity of some aid programs must be simplified in order to keep the analysis tractable.

These specification problems are compounded by the fact that institutional structures of local public good markets differ even within the same geographical area. Part of this problem can be alleviated by studying only the local governments within a given state. But the problem is not corrected that easily. Within the same state, the social decision mechanism among cities, suburban, and rural areas will differ by different socio-economic characteristics. Time series data and/or pooled cross-section data with some degree of arbitrariness should be considered.

Notes

1. Most of the following paragraph is quoted from Inman (1978).
2. See Holcombe (1983), chapters 3 and 4.
3. Examples include Borcharding and Deacon (1972), Bergstrom and Goodman (1973), Ladd (1975), McEachern (1978), Inman (1978), Lovell (1978), Black, Lewis and Link (1979), Holcombe (1980), Gramlich and Rubinfeld (1982), Munley (1984), Megdal (1984), Mathis and Zech (1986), Deno and Mehay (1987), and Turnbull (1987).
4. Romer and Rosenthal (1979), p.146.
5. See the following Chapter IV for a detailed form and implications.

CHAPTER IV. THE MODEL

A. The Model of Local Education Expenditure Determination

In this section, a simple model that can be used to analyze the behavior of a single-output (i.e., education) government or school district board will be presented. Following the theoretical derivation, the empirical specifications are developed. All of the analysis in this study is conducted under the median voter hypothesis. All of the specifications derived in this chapter could be considered extensions of the Borchering and Deacon (1972) model, since the study follows their method of incorporating both the publicness characteristic of public goods and the production technology into the analysis.

Under the median voter hypothesis, the community behavior (or governing authority behavior) can be modeled 'as if' it reflects the median voter's decision process. This representative voter maximizes his utility over the opportunity set defined by individual and community financial and technological constraints. Before the model is developed, the relevant variables for the analysis are defined as follows:

x = the private goods consumed, the price being equal to one for normalization

q_w = the amount of locally supplied good captured by the median voter, that is the education to a white pupil

q_b = the amount of locally supplied good captured by the median voter, that is the education to a black pupil

Q_w = the amount of locally supplied good (education) actually produced for white pupils

Q_b = the amount of locally supplied good (education) actually produced for black pupils

z = the socio-economic characteristics of the community

Y = the median voter's income

T = the median voter's tax bill

C_w = the cost of producing Q_w

C_b = the cost of producing Q_b

C = the total cost to provide education to the community (= $C_w + C_b$)

G = the unconditional block aid (grant)

m = the matching aid rate

i_w = input price vectors to produce Q_w , w_w and r_w

i_b = input price vectors to produce Q_b , w_b and r_b

N_w = the service consumption population, the number of white pupils in the district

N_b = the service consumption population, the number of black pupils in the district

V = the total property tax base

V_m = the median voter's tax base (= the value of median housing)

t = the property tax rate

$t \cdot V$ = the total property tax revenue

E_w = the expenditure for white pupil

E_b = the expenditure for black pupil

Under the standard consumer choice paradigm, the voter chooses private goods x , and publicly supplied goods q_w and q_b with the socio-economic characteristics z to maximize the utility function over the opportunity sets. The utility function and the opportunity sets are defined as follows:

$$(4.1) \quad U = U(x, q_w, q_b ; z)$$

$$(4.2) \quad Y = x + T$$

$$(4.3) \quad T = T(C, G, m)$$

$$(4.4) \quad C = C_w + C_b$$

$$(4.5) \quad C_w = C(Q_w, i_w)$$

$$(4.6) \quad C_b = C(Q_b, i_b)$$

$$(4.7) \quad q_w = h(Q_w, N_w)$$

$$(4.8) \quad q_b = h(Q_b, N_b)$$

The utility function, equation (4.1) is assumed to be regular strictly quasi-concave, and the median voter chooses the education level for both black and white pupils in the district.

Equation (4.2) is the voter's budget constraint and it states that income divided between the voter's tax bill and all other expenditures. Function (4.3) shows the relationship between the voter's tax bill, the production cost, and the education aid (grant) to local jurisdiction (school district) from higher levels of government. This relationship is determined by institutional constraints and higher government grant policy. Equations (4.5) and (4.6) are the cost functions, which show the relationship between the production levels, input prices, and total

production costs. The production technology for Q and local authority's input choice are embodied in these functions. Equations (4.7) and (4.8) are the congestion functions. They show that the relationship between the output produced, the number of persons served, and the amount of good captured by the voter.¹

Equations (4.7) and (4.8) can be solved for Q such that

$$(4.9) \quad Q_w = h^{-1}(q_w, N_w)$$

$$(4.10) \quad Q_b = h^{-1}(q_b, N_b)$$

and substitute (4.3), (4.4), (4.5), (4.6), (4.9) and (4.10) into (4.2) gives the budget constraint as

$$(4.11) \quad Y = x + T(q_w, q_b, N_w, N_b, G, i_w, i_b, m)$$

The community or school board, then, behaves as if the median voter maximizes $U(\bullet)$ subject to (4.11). The interior solution yields the reduced form demand equations for the public output measured as q_w and q_b ,

$$(4.12) \quad q_w = q_w(N_w, N_b, G, i_w, i_b, m, Y; z)$$

$$(4.13) \quad q_b = q_b(N_w, N_b, G, i_w, i_b, m, Y; z)$$

Since q is unobservable, (4.12) and (4.13) are transformed into the reduced form expenditure functions. Using (4.5) and (4.9), and (4.6) and (4.10), respectively,

$$(4.14) \quad E_w = C[h^{-1}(q_w, N_w), i_w] \\ = E_w(N_w, N_b, G, i_w, i_b, m, Y; z)$$

$$(4.15) \quad E_b = C[h^{-1}(q_b, N_b), i_b] \\ = E_b(N_w, N_b, G, i_w, i_b, m, Y; z)$$

The reduced forms (4.14) and (4.15) can be used to estimate the district response to grants-in-aid programs, income, and others.

Now the reduced form functions for q and, hence for E , are derived here. Assume the production process for Q exhibits constant returns. The hypothesis of constant returns to scale is supported by evidence summarized by Hirsch (1970) and also found in Borcherting and Deacon (1972). Hirsch cites empirical studies which indicate that average costs are constant over wide ranges of output for a large number of public services supplied by small, localized production units (e.g., police protection, local education, hospitals, sanitation, etc.). These findings together with cost minimization and elastic factor supply within each unit imply productions exhibiting constant returns to scale. Then the total production cost becomes proportional to Q ,

$$(4.16) \quad C_w = u_w(i_w) \cdot Q_w$$

$$(4.17) \quad C_b = u_b(i_b) \cdot Q_b$$

where $u_w(i_w)$ and $u_b(i_b)$ are unit cost functions, respectively. The local share of a dollar of additional expenditures is

$$(4.18) \quad LS = 1 - \text{marginal matching rate} \\ = 1 - m$$

If $LS < 1$, then matching grant program is in effect, and if $LS = 1$, then either the matching program is not in effect or there is no matching grant in the district. Since G is total unconditional aid to the community, the total cost to the community or school district of supplying Q_w and Q_b is

$$(4.19) \quad LS \cdot [u_w(i_w) \cdot Q_w + u_b(i_b) \cdot Q_b] - G$$

Assume the property taxation is the sole source of locally raised tax revenue given that the property taxes have been the primary source of local government tax revenue. Then total property tax revenue equals total cost to provide Q_w and Q_b as²

$$(4.20) \quad t \cdot V = LS \cdot [u_w(i_w) \cdot Q_w + u_b(i_b) \cdot Q_b] - G$$

The local property tax rate becomes

$$(4.21) \quad t = \frac{LS \cdot [u_w(i_w) \cdot Q_w + u_b(i_b) \cdot Q_b] - G}{V}$$

If the median voter's tax base is V_m , then his local tax bill is

$$(4.22) \quad t \cdot V_m = \frac{V_m}{V} \cdot \{LS \cdot [u_w(i_w) \cdot Q_w + u_b(i_b) \cdot Q_b] - G\}$$

where (V_m/V) is the median voter's tax share (TS).

Following Borchering and Deacon, congestion phenomena associated with Q can be expressed as

$$(4.23) \quad q_w = Q_w \cdot N_w^{-\pi_w}$$

$$(4.24) \quad q_b = Q_b \cdot N_b^{-\pi_b}$$

where π_w and π_b are the congestion index ($\pi \geq 0$). If $\pi = 0$, q is a pure public good; if $\pi = 1$, it is a pure private good; if $\pi > 1$, it is a congested good; and if $1 > \pi > 0$, then it is a quasi-public good. Rearranging (4.23) and (4.24),

$$(4.25) \quad Q_w = q_w \cdot N_w^{\pi_w}$$

$$(4.26) \quad Q_b = q_b \cdot N_b^{\pi_b}$$

Substitute (4.22), (4.25), and (4.26) into (4.11),

$$(4.27) \quad Y + TS \cdot G = x + TS \cdot LS \cdot [u_w(i_w) \cdot q_w \cdot N_w^{\pi_w} + u_b(i_b) \cdot q_b \cdot N_b^{\pi_b}]$$

$$= x + (TP_w \cdot q_w + TP_b \cdot q_b)$$

where $TP_w = TS \cdot LS \cdot u_w(i_w) \cdot N_w^{\pi_w}$ is the median voter's tax price to provide white education q_w , and $TP_b = TS \cdot LS \cdot u_b(i_b) \cdot N_b^{\pi_b}$ is the median voter's tax price to provide black education q_b .

Then, the Lagrangian is

$$L(x, q_w, q_b, \lambda) = U(x, q_w, q_b, z) + \lambda [Y + TS \cdot G - x - (TP_w \cdot q_w + TP_b \cdot q_b)]$$

The necessary and sufficient conditions for optimality are

(4.28)

$$L_x = U_x - \lambda = 0$$

$$L_{q_w} = U_{q_w} - \lambda \cdot TS \cdot LS \cdot u_w(i_w) \cdot N_w^{\pi_w} = U_{q_w} - \lambda \cdot TP_w = 0$$

$$L_{q_b} = U_{q_b} - \lambda \cdot TS \cdot LS \cdot u_b(i_b) \cdot N_b^{\pi_b} = U_{q_b} - \lambda \cdot TP_b = 0$$

$$L_\lambda = Y + TS \cdot G - x - TS \cdot LS \cdot [u_w(i_w) \cdot q_w \cdot N_w^{\pi_w} + u_b(i_b) \cdot q_b \cdot N_b^{\pi_b}]$$

$$= Y + TS \cdot G - x - (TP_w \cdot q_w + TP_b \cdot q_b) = 0$$

Solve for q_w and q_b ,

$$(4.29) \quad q_w = q_w(TP_w, TP_b, Y + TS \cdot G; z)$$

$$(4.30) \quad q_b = q_b(TP_w, TP_b, Y + TS \cdot G; z)$$

and the reduced form expenditure functions are

$$(4.31) \quad E_w = u_w(i_w) \cdot N_w^{\pi_w} \cdot q_w(TP_w, TP_b, Y + TS \cdot G; z)$$

$$(4.32) \quad E_b = u_b(i_b) \cdot N_b^{\pi_b} \cdot q_b(TP_w, TP_b, Y + TS \cdot G; z)$$

In order to make (4.31) and (4.32) estimable, the specific unit costs and the demand functional form are needed. Assume Cobb-Douglas production technology with labor(L) and capital(K) inputs,

$$Q_w = A_w \cdot L_w^{\delta} \cdot K_w^{(1-\delta)}$$

$$Q_b = A_b \cdot L_b^{\rho} \cdot K_b^{(1-\rho)}$$

With the input prices w_w , r_w , w_b and r_b , the cost functions can be derived such that minimize

$(w_w \cdot L_w + r_w \cdot K_w)$ subject to $Q_w = A_w \cdot L_w^{\delta} \cdot K_w^{(1-\delta)}$ and $Q_w = q_w \cdot N_w^{\pi_w}$ for white education and

minimize $(w_b \cdot L_b + r_b \cdot K_b)$ subject to $Q_b = A_b \cdot L_b^{\rho} \cdot K_b^{(1-\rho)}$ and $Q_b = q_b \cdot N_b^{\pi_b}$ for black

education.

Take the Lagrangian,

$$L(L_w, K_w, \lambda_w) = w_w \cdot L_w + r_w \cdot K_w + \lambda_w(q_w \cdot N_w^{\pi_w} - A_w \cdot L_w^{\delta} \cdot K_w^{(1-\delta)})$$

For interior solutions,

$$L_{L_w} = w_w - \lambda_w \cdot \delta \cdot A_w \cdot (L_w/K_w)^{(\delta-1)} = 0$$

$$L_{K_w} = r_w - \lambda_w \cdot (1-\delta) \cdot A_w \cdot (L_w/K_w)^{\delta} = 0$$

$$L_{\lambda_w} = q_w \cdot N_w^{\pi_w} - A_w \cdot L_w^{\delta} \cdot K_w^{(1-\delta)} = 0$$

Solve for L_w and K_w ,

$$L_w = [(w_w/r_w) \cdot (1-\delta)/\delta]^{(\delta-1)} \cdot (q_w \cdot N_w^{\pi_w} / A_w)$$

$$K_w = [(w_w/r_w) \cdot (1-\delta)/\delta]^{\delta} \cdot (q_w \cdot N_w^{\pi_w} / A_w)$$

Substitute L_w and K_w into cost identity,

$$w_w \cdot L_w + r_w \cdot K_w = (1/A_w) \cdot (w_w/\delta)^{\delta} \cdot (r_w/(1-\delta))^{(1-\delta)} \cdot N_w^{\pi_w} \cdot q_w$$

Divide by q_w to obtain the unit cost function,

$$(4.33) \quad u_w(i_w) \cdot N_w^{\pi_w} = (1/A_w) \cdot (w_w/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)} \cdot N_w^{\pi_w}$$

Similarly,

$$(4.34) \quad u_b(i_b) \cdot N_b^{\pi_b} = (1/A_b) \cdot (w_b/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)} \cdot N_b^{\pi_b}$$

It is also assumed that the demand is a constant elasticity multiplicative function of prices and income. Then (4.29) and (4.30) imply the specific demand functions.

$$(4.35) \quad q_w = f(z) \cdot a_w \cdot TP_w^{\alpha_1} \cdot TP_b^{\alpha_2} \cdot (Y + TS \cdot G)^{\alpha_3}$$

$$(4.36) \quad q_b = g(z) \cdot a_b \cdot TP_w^{\beta_1} \cdot TP_b^{\beta_2} \cdot (Y + TS \cdot G)^{\beta_3}$$

where TS = the median voter's tax share, α_1 = the own-price elasticity for white education, α_2 = the cross-price elasticity between white and black education, α_3 = aggregate income elasticity for white education, β_1 = the cross-price elasticity between black and white education, β_2 = the own-price elasticity for black education, β_3 = aggregate income elasticity for black education, and $f(z) = \sum_{j=1}^k (\gamma_j \cdot z_j)$ and $g(z) = \sum_{j=1}^k (\eta_j \cdot z_j)$ are functions of district socioeconomic characteristics. Community-wide differences such as population ratio between black and whites, private school enrollment, percent owner occupied housing and others may

be systematically related to income, grant, and prices. Those effects, if any, would be captured through the functions $f(z)$ and $g(z)$.

Taking the natural logarithm of (4.35) and (4.36) equations yield the familiar log-linear or constant elasticity logarithm (CEL) functional forms. The CEL is a very popular form in the empirical literature. It has convenient properties: its parameters are easily interpreted as elasticities and readily estimable for appropriate error structures. Using (4.31), (4.33), (4.34) and (4.35),

$$(4.37) \quad E_w = f(z) \cdot a_w \cdot (1/A_w)^{(1+\alpha_1)} \cdot (1/A_b)^{\alpha_2} \cdot (LS \cdot TS)^{(\alpha_1+\alpha_2)} \cdot [(w_w/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}]^{(1+\alpha_1)} \\ \cdot [(w_b/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}]^{\alpha_2} \cdot N_w^{(1+\alpha_1) \cdot \pi_w} \cdot N_b^{\alpha_2 \cdot \pi_b} \cdot (Y + TS \cdot G)^{\alpha_3}$$

Likewise, using (4.32), (4.33), (4.34) and (4.36),

$$(4.38) \quad E_b = g(z) \cdot a_b \cdot (1/A_w)^{\beta_1} \cdot (1/A_b)^{(1+\beta_2)} \cdot (LS \cdot TS)^{(\beta_1+\beta_2)} \cdot [(w_w/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}]^{\beta_1} \\ \cdot [(w_b/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}]^{(1+\beta_2)} \cdot N_w^{\beta_1 \cdot \pi_w} \cdot N_b^{(1+\beta_2) \cdot \pi_b} \cdot (Y + TS \cdot G)^{\beta_3}$$

Dividing (4.37) and (4.38) by N_w and N_b on both sides, respectively, and taking the natural logarithm, the reduced form estimating equations will be derived.

$$(4.39) \quad \ln e_w = \ln a_w' + (\alpha_1 + \alpha_2) \ln (LS \cdot TS) + (1 + \alpha_1) \ln [(w_w/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}] \\ + \alpha_2 \ln [(w_b/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}] + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w + \alpha_2 \cdot \pi_b \ln N_b$$

$$+ \alpha_3 \ln (Y + TS \cdot G) + \ln f(z) + \varepsilon_w$$

$$(4.40) \ln e_b = \ln a_b' + (\beta_1 + \beta_2) \ln (LS \cdot TS) + \beta_1 \ln [(w_w/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}] \\ + (1 + \beta_2) \ln [(w_b/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}] + \beta_1 \cdot \pi_w \ln N_w + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b \\ + \beta_3 \ln (Y + TS \cdot G) + \ln g(z) + \varepsilon_b$$

where $e_w = E_w/N_w$, $e_b = E_b/N_b$, $a_w' = a_w \cdot (1/A_w)^{(1+\alpha_1)} \cdot (1/A_b)^{\alpha_2}$, $a_b' = a_b \cdot (1/A_w)^{\beta_1} \cdot (1/A_b)^{(1+\beta_2)}$, and ε_w and ε_b are error terms. These equations are linear in regressors. Hence, they can be estimated using OLS technique. OLS estimators yields unbiased reduced form parameter estimates which are also efficient if the errors are independently distributed with zero mean and constant variance σ^2 .

The above equations show that per pupil expenditure is a function of median voter's tax share, wage rate for both black and white education inputs, number of both black and white pupils, and aggregated income that is the median income plus the median voter's perceived share of total grants. The presence of intergovernmental grants in aggregated income term is of particular interest. This theoretically derived model shows the grant could affect median voter's behavior for provision of local public good. The inclusion of inter-racial factors could be justified since the median voter (or voters) decides the expenditure level of education for both black and white schools simultaneously through his decision-making process, that is voting. The model is, therefore, consistent with the economic theory of

majority rule. Finally, the model allows the estimation of the price elasticities, aggregated income elasticities, and the degree of publicness of the education service.

B. The Specification of the Expenditure Equation

Here the actual specifications that will be estimated are constructed. First of all, all the specification hypotheses are derived under the assumption of a constant user cost of capital. Production functions across school district units are assumed to be identical and taken to be of the Cobb-Douglas constant returns technology. Labor and capital are the only factors of production and available in perfectly elastic supply. However, capital is assumed to be perfectly mobile between communities, whereas labor is not. This implies that the rental rate, r , is identical across the communities, but wage rate can differ. The omission of r would bias the results to the extent that r varies over time, but the direction of any bias is not clear immediately. It is, therefore, hoped that any time variation in r is negligible for the sample periods, and thus will not have any adverse impact on estimates. Equations (4.33) and (4.34) can be rewritten as

$$(4.41) \quad u_w(i_w) \cdot N_w^{\pi_w} = a' \cdot w_w^{\delta} \cdot N_w^{\pi_w}$$

$$(4.42) \quad u_b(i_b) \cdot N_b^{\pi_b} = a'' \cdot w_b^{\rho} \cdot N_b^{\pi_b}$$

where $a' = (1/A_w) \cdot (1/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}$ and $a'' = (1/A_b) \cdot (1/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}$. With $m = 0$ since there was no matching aid over the time period covered in this study, and with (4.41) and (4.42), the equation (4.39) and (4.40) become the estimating equations such that

$$(4.43) \quad \ln e_w = \ln a + (\alpha_1 + \alpha_2) \ln TS + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^\rho + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w \\ + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln (Y + TS \cdot G) + \ln f(z) + \varepsilon_w$$

$$(4.44) \quad \ln e_b = \ln b + (\beta_1 + \beta_2) \ln TS + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^\rho + \beta_1 \cdot \pi_w \ln N_w \\ + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln (Y + TS \cdot G) + \ln g(z) + \varepsilon_b$$

where $a = a_w \cdot (1/A_w)^{(1+\alpha_1)} \cdot (1/A_b)^{\alpha_2} \cdot [(1/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}]^{(1+\alpha_1)} \cdot [(1/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}]^{\alpha_2}$ and $b = a_b \cdot (1/A_w)^{\beta_1} \cdot (1/A_b)^{(1+\beta_2)} \cdot [(1/\delta)^\delta \cdot (r_w/(1-\delta))^{(1-\delta)}]^{\beta_1} \cdot [(1/\rho)^\rho \cdot (r_b/(1-\rho))^{(1-\rho)}]^{(1+\beta_2)}$.

The above equations show that the appropriate income measure in the demand function is the aggregate income term $(Y + TS \cdot G)$. Only Perkins (1977) and Turnbull (1987) use the aggregate income term, and most other studies (Feldstein (1975), Ladd (1975), Black, Lewis, and Link (1979), Megdal (1983), and many more) use separate income and grant terms. But none of them present any theoretical justification for the disaggregate income and grant terms. However, Turnbull (1987) compares the various demand specifications to his theoretically-derived model, which contains aggregate income. Using the Cox specification test, however, the result supports the popular notion that allowing for separate voter income

and grant is superior to treating grant as a supplement to income, though theoretically not preferred. Respecifying demand functions (4.35) and (4.36) as

$$(4.45) \quad q_w = f(z) \cdot a_w \cdot TP_w^{\alpha_1} \cdot TP_b^{\alpha_2} \cdot Y^{\alpha_3} \cdot g^{\alpha_4}$$

$$(4.46) \quad q_b = g(z) \cdot a_b \cdot TP_w^{\beta_1} \cdot TP_b^{\beta_2} \cdot Y^{\beta_3} \cdot g^{\beta_4}$$

where $g = G/(N_w + N_b)$, i.e., per pupil unconditional block grants. Then, the reduced form estimating equations become

$$(4.47) \quad \ln e_w = \ln a + (\alpha_1 + \alpha_2) \ln TS + (1 + \alpha_1) \ln w_w^{\delta} + \alpha_2 \ln w_b^{\rho} + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w \\ + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g + \ln f(z) + \varepsilon_w$$

$$(4.48) \quad \ln e_b = \ln b + (\beta_1 + \beta_2) \ln TS + \beta_1 \ln w_w^{\delta} + (1 + \beta_2) \ln w_b^{\rho} + \beta_1 \cdot \pi_w \ln N_w \\ + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g + \ln g(z) + \varepsilon_b$$

where α_3 = the income elasticity for white education, α_4 = the grant elasticity for white education, β_3 = the income elasticity for black education, β_4 = the grant elasticity for black education, and the rest of coefficients are the same as before.

In addition to the ad hoc adjustment of grant, the grant term, g (the unconditional total federal and state block aid per pupil) can be separated by federal and state, or by federal, state categorical and state block (equalization fund) grant. Most studies deal with the impact of the

grant separately as seen in the literature review in chapter II. Thus, the following estimating equations are derived to see the grant impact separately.

$$(4.49) \ln e_w = \ln a + (\alpha_1 + \alpha_2) \ln TS + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w \\ + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g_f + \alpha_5 \ln g_s + \ln f(z) + \varepsilon_w$$

$$(4.50) \ln e_b = \ln b + (\beta_1 + \beta_2) \ln TS + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^p + \beta_1 \cdot \pi_w \ln N_w \\ + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g_f + \beta_5 \ln g_s + \ln g(z) + \varepsilon_b$$

$$(4.51) \ln e_w = \ln a + (\alpha_1 + \alpha_2) \ln TS + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w \\ + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g_f + \alpha_5 \ln g_c + \alpha_6 \ln g_e + \ln f(z) + \varepsilon_w$$

$$(4.52) \ln e_b = \ln b + (\beta_1 + \beta_2) \ln TS + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^p + \beta_1 \cdot \pi_w \ln N_w \\ + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g_f + \beta_5 \ln g_c + \beta_6 \ln g_e + \ln g(z) + \varepsilon_b$$

where g_f = per pupil total federal education aid, g_s = per pupil total state education aid ($= g_c + g_e$), g_c = per pupil state categorical education aid, and g_e = per pupil state equalization fund.

The expenditure estimation equations, so far, have been based on the assumption of complete exporting or no nonresidential property tax shifting onto residential property owners. However, partial shifting or incomplete exporting occurs if some of the nonresidential tax burden is shifted onto residential property owners. If nonresidential property taxes are

shifted, the community tax base composition may alter the tax price perceived by residential voters. This is based on the premise that voters perceive that firms are mobile in response to inter-community fiscal differentials. Thus, voters recognize that greater education expenditure (hence higher tax rate) may prompt firms to move their assets to another jurisdiction. An increase in q reduces the nonresidential tax base, hence it increases the residential voter's share of the community tax burden.

Ladd (1975) examines the possibility that the proportion of the nonresidential property tax perceived as borne by local residents could be somewhere between zero and unity. As Greene and Munley (1984) pointed out, although nonresidential tax bills may be paid for almost entirely by nonresidential property owners, adjustment in a multijurisdictional setting could lead to a far different incidence of their real burdens. These increased tax burdens could lead to decreased returns for factors of production owned by residents or increased prices for residential consumers. This might be perceived by local taxpayer-voters and could explain Ladd's finding that less than 100% of these nonresidential taxes are perceived to be exported.

If the residential property owners in a community perceive themselves as bearing part of the property tax on nonresidential property,³ the tax share defined above needs to be modified: If a resident perceives some forward shifting of nonresidential property taxes, the higher the nonresidential portions of tax base, the lower the spending on education, other things being equal. In this case, the homeowner bears not only the taxes on his home (residential property), but also some of the nonresidential property tax burden. The tax share as defined previously would understate the price perceived by the homeowner. By multiplying

the tax share by $[1 + \theta \cdot (V_{nr}/V)]$, where V_{nr}/V is the nonresidential fraction of the tax base and θ is a parameter to be estimated, this effect can be incorporated into the model.⁴

Under this specification, the larger the value of θ , the greater the degree of perceived shifting. The estimated value of θ can be negative with the type of fiscal illusion suggested by Filimon, Romer, and Rosenthal (1982). A priori reasoning suggests that local residents can export to nonresidential owners more than 100% of taxes levied on such property. Filimon, Romer, and Rosenthal have examined the possibility that it could be in the interests of an individual attempting to maximize the size of the local budget to create fiscal illusion that might either artificially deflate the voter's perceived level of intergovernmental aid or artificially deflate their perception of taxes paid by others. In this case, even if voters recognize that some shifting of tax burdens from nonresidential property to themselves might occur, conceivably they still could perceive exportation of more than 100% of such property taxes.

In order to estimate this effect, $[1 + \theta \cdot (V_{nr}/V)]$ will be added to equations (4.43), (4.44), (4.47), (4.48), (4.49), (4.50), (4.51) and (4.52).

$$\begin{aligned}
 (4.53) \quad \ln e_w = & \ln a + (\alpha_1 + \alpha_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p \\
 & + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln \{Y + TS \cdot [1 + \theta \cdot (V_{nr}/V)] \cdot G\} \\
 & + \ln f(z) + \varepsilon_w
 \end{aligned}$$

$$(4.54) \quad \ln e_b = \ln b + (\beta_1 + \beta_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^p$$

$$\begin{aligned}
& + \beta_1 \cdot \pi_w \ln N_w + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln \{Y + TS \cdot [1 + \theta \cdot (V_{nr}/V)] \cdot G\} \\
& + \ln g(z) + \varepsilon_b
\end{aligned}$$

$$\begin{aligned}
(4.55) \quad \ln e_w &= \ln a + (\alpha_1 + \alpha_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p \\
& + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g + \ln f(z) + \varepsilon_w
\end{aligned}$$

$$\begin{aligned}
(4.56) \quad \ln e_b &= \ln b + (\beta_1 + \beta_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^p \\
& + \beta_1 \cdot \pi_w \ln N_w + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g + \ln g(z) + \varepsilon_b
\end{aligned}$$

$$\begin{aligned}
(4.57) \quad \ln e_w &= \ln a + (\alpha_1 + \alpha_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p \\
& + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g_f + \alpha_5 \ln g_s \\
& + \ln f(z) + \varepsilon_w
\end{aligned}$$

$$\begin{aligned}
(4.58) \quad \ln e_b &= \ln b + (\beta_1 + \beta_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + \beta_1 \ln w_w^\delta + (1 + \beta_2) \ln w_b^p \\
& + \beta_1 \cdot \pi_w \ln N_w + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g_f + \beta_5 \ln g_s \\
& + \ln g(z) + \varepsilon_b
\end{aligned}$$

$$\begin{aligned}
(4.59) \quad \ln e_w &= \ln a + (\alpha_1 + \alpha_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + (1 + \alpha_1) \ln w_w^\delta + \alpha_2 \ln w_b^p \\
& + [(1 + \alpha_1) \cdot \pi_w - 1] \ln N_w + \alpha_2 \cdot \pi_b \ln N_b + \alpha_3 \ln Y + \alpha_4 \ln g_f + \alpha_5 \ln g_c \\
& + \alpha_6 \ln g_e + \ln f(z) + \varepsilon_w
\end{aligned}$$

$$\begin{aligned}
(4.60) \quad \ln \epsilon_b = & \ln b + (\beta_1 + \beta_2) \ln \{TS \cdot [1 + \theta \cdot (V_{nr}/V)]\} + \beta_1 \ln w_w^{\delta} + (1 + \beta_2) \ln w_b^{\rho} \\
& + \beta_1 \cdot \pi_w \ln N_w + [(1 + \beta_2) \cdot \pi_b - 1] \ln N_b + \beta_3 \ln Y + \beta_4 \ln g_f + \beta_5 \ln g_c \\
& + \beta_6 \ln g_e + \ln g(z) + \epsilon_b
\end{aligned}$$

The above specifications require nonlinear estimation algorithm since they exhibit the nonlinearity in parameters. They will be estimated using nonlinear least squares (NLS), which should yield consistent parameter estimates.

Notes

1. With the congestion function, $h_Q > 0$ and $h_N \leq 0$ are assumed since the increase in production will increase the amount of consumption, and increase in consuming population will either decrease the amount of consumption or leave it unchanged. If $h_Q = 1$, there is no consumption congestion, and if $h_Q < 1$, there is. If $h_N = 0$, there is no consumption congestion, and if $h_N < 0$, Q is a congested good.
2. The expression (4.20) is the community or school district budget constraint to provide public service q (education), since it can be written as $t \cdot V + G = LS \cdot [u_w(i_w) \cdot Q_w + u_b(i_b) \cdot Q_b]$, which shows that total revenue equals total cost for provision of q .
3. Previous studies showed that the nonresidential property tax base is divided into the combination of commercial, industrial, agricultural, rural, and vacant property. See Ladd (1975), Billings and Folsom (1980), and Megdal (1984). However, because of data availability over the time periods covered in this study, the total tax base is divided into two categories such as residential and nonresidential property.
4. This ad hoc way of treating the effects of nonresidential property is similar to those derived theoretically by Ladd (1975) and others, as in endnote 3.

CHAPTER V. THE EMPIRICAL RESULTS

A. Data

The sample data set consists of a pooled cross-sectional time series of 23 Maryland counties for a 27-year time period, 1929 through 1955. Schools were segregated by race throughout this period. There were 23 white school systems and 22 black school systems. There were no black schools in Garret County. The advantage of using Maryland is that school district and county boundaries are coterminous. This study covers the grade schools, grade 1 through 8. Since all but one county provided both black and white schools, the data are well-suited to the models described in the previous chapter. Some counties did not have their own high schools for black children during this period; thus, high school enrollment and expenditure decisions might involve more than one county, and it is inappropriate for the analysis of this study.

The data set was compiled mainly from the *Annual Reports of the State of Maryland Board of Education*. This data set is drawn from the same source as Orazem (1987) and TenHoeve (1992). The variable definitions are listed in Table 5-1. The data set in the *Reports* includes total current expenditure, number of pupils belonging or attending, teachers salaries, number of teachers, number of children enrolled in private schools, number of private schools, and much more. Those are reported separately for black and white schools and aggregated by the county level. Note that per pupil expenditure is calculated by dividing total current expenditure by average number of pupils belonging (enrolled).¹ Some other data sets that

Table 5-1. Variable definitions

Variable (i = w for white b for black)	Definition
E_i	total current expenditures in real terms by county
e_i	per pupil expenditures in real terms by county ($=E_i/N_i$)
N_i	average number of pupils belonging (enrolled) in grade school by county
Y	per capita average personal income in real terms by county as a proxy for median income
w_i	average salaries of teachers in real terms by county as a proxy for wage rate
δ, p	labor share for white and black, respectively, across counties
TS	median voter's tax share ($= V_m/V$)
V	total county basis taxable at full rate in real terms, i.e., property tax base
V_m	value of median housing in real terms by county
V_{nr}	value of county nonresidential property in real terms
V_r	value of county residential property in real terms
G	total state and federal unconditional education block aid to county in real terms
g	per pupil total state and federal unconditional education block aid to county in real terms
g_f	per pupil total federal education aid to county in real terms
g_s	per pupil total state education aid to county in real terms
g_c	per pupil total state categorical education aid to county in real terms
g_e	per pupil total state equalization fund to county in real terms
L	index number of average value per acre of farm real estate in Maryland (1912-14 = 100)

are reported by county are observations on federal aid, state aid, equalization fund, and county school tax, but their usage is not reported separately between black and white schools.

Nonetheless, the aid data, as well as expenditure and other series, are uniformly defined, and the reports are regarded as accurate since each district is required to file the necessary statistics. This can be another advantage to using the data set of Maryland school districts.

The population figures used here are taken from an unpublished vital statistics table provided by officials of the State of Maryland Board of Education.²

The per capita average personal income is used as a surrogate for the median voter's income since median income by state or by county level is not available for the time period covered in this study. This is justified under the assumption that the two quantities are highly correlated.³ Annual total personal income for the state of Maryland is taken from the *State Personal Income: 1929-1987*, Bureau of Economic Analysis, U.S. Department of Commerce. However, as there is no personal income data by county level, this must be estimated. The county-level total employment and sectoral employment level by industry for the years 1940, 1950, and 1960 are taken from *Regional Employment by Industry, 1940-1970*. For 1930, they are taken from the *15th Census of the United States: 1930*, Bureau of the Census, U.S. Department of Commerce. With the county-level occupational distribution, or the employment level by industry for 1930, 1940, 1950, and 1960, each county's employment level by industry is interpolated for the years between 1930 and 1940, 1940 and 1950, and 1950 and 1960. Then, each county's proportion of employment level to total state employment level in each industry is calculated for those years. Now, from the *State Personal Income: 1929-1987* the earnings by industry for the state for each year of 1929 through 1955

are taken, and they are multiplied by each county's proportions of employment level calculated above. This procedure generates each county's earnings by each industry. When each industry's earnings (personal income) for any one county for any given year are added, it becomes the total personal income for the county for any given year. Then, the county's total personal income is divided by population to generate per capita personal income for that year. This income data series shows a pattern similar to the state income data series over the years, and it is used as a surrogate of median income.

The expenditure share attributed to labor, that is, the labor share for whites and blacks, δ and ρ , should be estimated, too. It should be constant across the counties as a necessary condition for the constant-returns-to-scale Cobb-Douglas specification. Following Borcharding and Deacon (1972) and Perkins (1977), the labor share is estimated by averaging the ratio of expenditures for salaries to total expenditures across all school districts for a given year. The derivation of labor share is as follows:

The production function, $Q_w = A_w \cdot L_w^\delta \cdot K_w^{(1-\delta)}$, and the total cost constraint, $TC_w = w_w \cdot L_w + r_w \cdot K_w$, imply that

$$MP_{L_w} = \delta \cdot A_w \cdot L_w^{(\delta-1)} \cdot K_w^{(1-\delta)}$$

$$MP_{K_w} = (1-\delta) \cdot A_w \cdot L_w^\delta \cdot K_w^{-\delta}$$

If the first order conditions of constrained output maximization are satisfied, then

$$w_w/r_w = MP_{Lw}/MP_{Kw} = [\delta/(1-\delta)]/(K_w/L_w)$$

Then the following is derived.

$$\delta = w_w \cdot L_w / (w_w \cdot L_w + r_w \cdot K_w)$$

The constant term δ is the labor share of the total cost of education for white schools where $w_w \cdot L_w$ is the labor cost and $(w_w \cdot L_w + r_w \cdot K_w)$ is the total cost. This labor share is calculated separately for each year throughout the time period. Similarly, ρ is calculated as

$$\rho = w_b \cdot L_b / (w_b \cdot L_b + r_b \cdot K_b)$$

Before going into the estimation of expenditure equations, one should note that the median housing value (V_m) is included in the reduced form estimating equation as a numerator of the tax share variable. However, the median housing values are available only for 1930, 1940 and 1950 from the *Census of the United States*. Thus each year's median housing values have to be estimated for the pooled data set.

Using the ordinary least squares technique, an estimate of median housing value is derived by regressing median housing value on the index number of average value per acre of farm real estate for Maryland, L , residential property value, V_r , the square of residential property value, V_r^2 , and the dummy variables for each county, CO_i , with no intercept for the

data set of 1930, 1940, and 1950. The index number of average value per acre of farm real estate is used as a proxy for the land value, and it is taken from various issues of *Farm Real Estate Market Developments*, Economic Research Service, U.S. Department of Agriculture. Since the state of Maryland had been regarded as mostly an agricultural state, the farm real estate value could reflect the land value in general. Residential property value is included since median housing value would follow the trend of residential property value. Dummy variables are included to capture the county-specific characteristics of the trend of the median housing value. Since these variables are assumed exogenous, they will be uncorrelated with the error term of expenditure equation. Hence the estimate of median housing value will be uncorrelated with that error term as well.

The regression result is reported in Table 5-2. The land value and residential property value have positive coefficients and are significant at the 1% level. All county dummy variables except CO₁₃ (Howard), CO₁₅ (Montgomery) and CO₁₆ (Prince George's) also show significant t-statistics. Then, the estimates from this regression are used to project each county's predicted median housing values for the years 1929-1955. Those predicted values are utilized for further empirical study.

Including the above estimates, the sample statistics for all variables used in this study are presented in Table 5-3. In Table 5-4, the trends of major variables over the years are listed as averages across the counties for each year.

Table 5-2. Regression result for median housing value, V_m

Variable	Estimate	t-statistics
L(land value)	29.9027*	(14.56)
$V_r/10^6$ (residential property)	46.4075*	(4.02)
$(V_r/10^6)^2$ (square of residential property)	-0.061107**	(-2.22)
CO ₁	-3604.1100*	(-4.70)
CO ₂	-1930.4959*	(-2.89)
CO ₃	-5010.4241*	(-4.53)
CO ₄	-1881.9300*	(-4.24)
CO ₅	-1922.9616*	(-4.34)
CO ₆	-1682.8243*	(-3.25)
CO ₇	-2037.7551*	(-3.96)
CO ₈	-1834.2263*	(-4.16)
CO ₉	-3151.1873*	(-6.90)
CO ₁₀	-2901.1914*	(-4.58)
CO ₁₁	-2718.6557*	(-6.06)
CO ₁₂	-1680.8096*	(-2.90)
CO ₁₃	-663.0505	(-1.48)
CO ₁₄	-2604.4005*	(-5.86)
CO ₁₅	1532.4563	(1.65)
CO ₁₆	-1316.2307	(-1.55)
CO ₁₇	-2585.0537*	(-5.79)
CO ₁₈	-2135.9156*	(-4.84)
CO ₁₉	-3202.4408*	(-7.26)
CO ₂₀	-2500.0633*	(-5.47)
CO ₂₁	-3103.7668*	(-4.17)
CO ₂₂	-2260.3167*	(-4.63)
CO ₂₃	-2449.2320*	(-5.34)
R ²	0.9672	
F(26,69)	154.71	

* significant at the 1% level

** significant at the 5% level

Table 5-3. Sample statistics

Variable	Mean	Standard Deviation
E_w	524773	669109
E_b	82568	86789
e_w	108.17	30.99
e_b	80.55	40.24
N_w	4911	5131
N_b	1055	752
Y	1172	423.83
w_w	2354	573.50
w_b	1884	867.33
δ	0.6646	0.0281
ρ	0.7050	0.0376
TS	0.000118	0.000092
V	78550919	97096484
V_m	5168.51	3053.83
V_{nr}	11160084	21165667
V_r	67390835	80676890
L	154.22	65.20
G	536027	637890
$(Y+TS \cdot G)$	1241.91	454.13
g	103.71	71.82
g_r	9.63	23.95
g_s	94.08	61.92
g_c	50.81	21.42
g_e	43.29	44.61

Table 5-4. Trends of the statistics^a, 1929-1955

Year	N _w	N _b	E _w	E _b	Y+TS · G	Y
1929	4427	1111	68.16	35.03	844.05	829.92
1930	4481	1101	70.90	36.84	766.38	753.98
1931	4539	1118	78.66	40.74	814.79	799.91
1932	4619	1123	86.88	44.85	699.97	683.58
1933	1683	1138	87.84	46.28	688.50	676.73
1934	4658	1127	99.83	52.35	929.71	911.73
1935	4652	1105	79.74	43.54	781.23	763.97
1936	4618	1081	84.38	47.59	875.45	855.92
1937	4603	1055	85.87	49.14	907.02	885.37
1938	4573	1037	94.72	54.84	866.09	843.13
1939	4603	1044	96.48	62.39	916.10	889.91
1940	4574	1033	101.74	65.98	975.07	948.29
1941	4584	1018	98.19	65.25	1181.98	1159.82
1942	4652	1009	94.96	69.63	1409.41	1386.07
1943	4750	992	89.29	71.09	1562.99	1538.60
1944	4797	987	102.06	82.23	1637.33	1604.95
1945	4866	1014	104.43	82.70	1568.28	1531.54
1946	4208	968	108.36	84.24	1532.18	1487.91
1947	4262	979	106.89	86.27	1365.57	1312.59
1948	4436	991	130.18	104.38	1425.17	1338.66
1949	4746	1023	140.78	115.98	1445.98	1357.14
1950	5151	1045	140.88	120.85	1544.12	1458.43
1951	5518	1044	135.03	121.42	1637.47	1531.85
1952	5936	1051	145.89	130.11	1740.29	1614.72
1953	6542	1063	152.58	141.07	1820.80	1672.21
1954	7224	1091	158.60	152.34	1788.34	1644.23
1955	7670	1131	173.12	167.73	1807.18	1653.75

^a Figures are averages of county data for each year.

Table 5-4. (continued)

Year	g	gr	gs	gc	ge
1929	30.16	0.44	29.72	23.68	6.09
1930	27.10	0.44	26.67	19.36	7.34
1931	32.92	0.62	32.30	23.72	8.63
1932	44.09	0.66	43.43	30.34	13.13
1933	41.03	0.83	40.20	27.39	12.85
1934	60.83	0.90	59.93	53.69	6.28
1935	57.19	0.77	56.42	49.43	7.04
1936	61.53	8.66	52.87	44.00	8.91
1937	65.48	13.69	51.79	43.31	8.53
1938	70.11	6.02	64.10	45.55	18.57
1939	78.81	12.37	66.44	46.20	20.26
1940	83.41	14.90	68.51	46.86	21.67
1941	70.24	3.95	66.29	45.75	20.56
1942	69.35	3.53	65.83	42.44	23.40
1943	66.23	3.37	62.86	41.59	21.29
1944	81.17	1.88	79.29	49.99	29.32
1945	82.33	5.48	76.85	46.15	30.72
1946	98.06	2.90	95.16	48.04	47.13
1947	96.51	8.58	87.92	42.37	45.56
1948	160.00	8.08	151.93	65.93	86.01
1949	164.56	8.42	156.14	66.02	90.12
1950	171.10	10.92	160.18	70.35	89.83
1951	186.30	11.33	174.97	83.58	91.38
1952	199.24	19.37	179.87	80.04	99.82
1953	224.05	40.85	183.19	81.84	101.36
1954	208.10	33.58	174.52	76.56	97.97
1955	219.83	42.54	177.29	79.12	98.18

B. Econometric Results

1. Linear models (no property tax shifting)

The method of ordinary least squares (OLS) was employed to estimate the coefficients of equations (4.43), (4.47), (4.49) and (4.51) for white schools, and of equations (4.44), (4.48), (4.50) and (4.52) for black schools; the dependent variables are the natural log of per pupil total current expenditures for white and black, respectively, and no parameter identification constraints are imposed. Socioeconomic variables are not added to the equation to estimate. Under each hypothesis, the OLS estimates are unbiased and efficient. All of these equations are significant, as indicated by the F statistics. The results are presented in Table 5-5 and 5-6. Coefficient estimates and their standard errors are listed. The asterisk (* or **) next to a coefficient value indicates that the coefficient estimate is significantly different from zero at either 1% or 5% significance level according to a two-tailed t test. Also listed are values for the coefficient of multiple determination adjusted for degrees of freedom, \bar{R}^2 ; the sum of squared residuals, SSR; the values of testing the overall significance of a set of explanatory variables, $F(\cdot)$; and their corresponding degrees of freedom, $N-K$, where N is the number of observation and K is the number of independent variables including the constant term.

a. Results for white schools

First, examining the results of theoretically-derived model (4.43) which includes an aggregated income term, all coefficients are significantly different from zero. The median voter's tax share is related negatively to expenditure for white pupils, as expected, and it is

Table 5-5. OLS estimates for white schools^a

Variable	(4.43)	(4.47)	(4.49)	(4.51)
intercept	0.5310** (0.2422)	1.3864* (0.1945)	1.5340* (0.1952)	1.6295* (0.1904)
ln (TS)	-0.0389** (0.0182)	-0.0166 (0.0141)	-0.0194 (0.0144)	0.0285 (0.0147)
ln w_w^{δ}	0.5935* (0.0467)	0.2322* (0.0417)	0.2557* (0.0417)	0.2530* (0.0402)
ln w_b^p	-0.2288* (0.0435)	0.0164 (0.0368)	0.0044 (0.0365)	0.0504 (0.0360)
ln N_w	-0.1320* (0.0145)	-0.0458* (0.0119)	-0.0490* (0.0131)	-0.0416* (0.0128)
ln N_b	-0.0394* (0.0091)	0.0114 (0.0076)	0.0126 (0.0076)	0.0188** (0.0075)
ln (Y+TS · G)	0.4571* (0.0216)			
ln Y		0.1471* (0.0227)	0.1324* (0.0230)	0.1084* (0.0228)
ln g		0.2468* (0.0122)		
ln g_r			0.0185* (0.0032)	0.0201* (0.0031)
ln g_s			0.2228* (0.0142)	
ln g_c				0.2927* (0.0189)
ln g_e				0.0102* (0.0027)
\bar{R}^2	0.6679	0.7916	0.7933	0.8047
SSR	14.6886	9.2013	9.1127	8.5939
F(·)	199.759	322.789	285.411	272.471
d.f.	587	586	585	584

a Standard errors are in parentheses.

* significant at the 1% level

** significant at the 5% level

Table 5-6. OLS estimates for black schools^a

Variable	(4.44)	(4.48)	(4.50)	(4.52)
intercept	-4.4332* (0.3612)	-3.1161* (0.2918)	-2.9272* (0.2953)	-2.8134* (0.2912)
ln (TS)	-0.0938* (0.0271)	-0.0487** (0.0212)	-0.0446** (0.0218)	-0.0342 (0.0225)
ln w_w^{δ}	0.5460* (0.0697)	0.0128 (0.0626)	0.0354 (0.0631)	0.0496 (0.0615)
ln w_b^{ρ}	-0.0488 (0.0649)	0.3138* (0.0552)	0.2841* (0.0552)	0.3517* (0.0551)
ln N_w	-0.0478** (0.0217)	0.0890* (0.0179)	0.0979* (0.0198)	0.1013* (0.0196)
ln N_b	-0.2153* (0.0136)	-0.1378* (0.0114)	-0.1363* (0.0115)	-0.1271* (0.0115)
ln (Y+TS ·G)	1.0067* (0.0323)			
ln Y		0.5370* (0.0341)	0.5222* (0.0348)	0.4917* (0.0348)
ln g		0.3777* (0.0183)		
ln g_r			0.0194* (0.0048)	0.0235* (0.0047)
ln g_s			0.3607* (0.0214)	
ln g_c				0.4805* (0.0290)
ln g_e				0.0092** (0.0041)
\bar{R}^2	0.7797	0.8602	0.8590	0.8638
SSR	32.6702	20.7035	20.8486	20.1056
F(·)	350.894	522.189	452.453	418.729
d.f.	587	586	585	584

a Standard errors are in parentheses.

* significant at the 1% level

** significant at the 5% level

quite low. The -0.0389 value indicates that demand for education is price inelastic. Most other studies, except Feldstein's, concluded that demand for education is price inelastic, although this estimate is lower than most. The coefficient of the wage rate of white teachers shows positive elasticity, while that of black teachers shows a negative sign, but both are inelastic. This implies that the 1% increase in white teacher's wage rate results in the 0.5935% increase in expenditure for white pupils, and the 1% increase in black teacher's wage rate decreases expenditure for white pupils by 0.2288%. The coefficients of the number of black and white pupils show negative sign, which means that as more pupils are attending the school, the expenditure share per pupil would decrease. The coefficient of the aggregated income variable is positive, as expected, and significantly different from zero. Using the mean values for per pupil expenditure for white schools and aggregated income, the 0.4571 elasticity implies that an additional dollar of aggregated income leads to an increase in spending of 4 cents.

For equation (4.47), which separates median income and per pupil grant terms, the tax share shows a negative elasticity, but it is not significantly different from zero. The coefficients of the black teacher's wage rate and the number of black pupils also are not significantly different from zero to explain per pupil expenditure for whites. White teachers' wage rate and the number of white pupils estimated coefficients are significantly different from zero, but they exhibit much smaller elasticity than equation (4.43). The income elasticity of expenditure is 0.1471, which is very inelastic but significantly different from zero. An additional dollar of income leads to an increase in spending of 1.36 cents. It is interesting to note that income elasticity here is much smaller than for most studies that dealt with more recent data sets. The coefficient of the total state and federal grant variable, g , is positive and significantly different

from zero. The expenditure would be increased by \$0.26 with an additional dollar of any kind of grants. This suggests that districts might use any additional fund to relieve the property tax burden. However, this elasticity, 0.2468, is greater than Ladd's (1975) result.

The results of equation (4.49), where aggregated grants are separated by federal education aid and state education aid, are similar to those of equation (4.47). The income elasticity is slightly lower than for equation (4.47). An additional dollar of income results in 1.22 cents of additional spending. The coefficients of federal education aid and total state education aid are positive, as expected, and significantly different from zero. Those elasticities, 0.0185 and 0.2228, imply that districts would increase spending by \$0.21 and \$0.26 in response to an additional dollar of federal aid or total state aid, respectively.

Total state education aid is separated by state categorical aid and equalization fund in equation (4.51) to check whether they have any specific impact on expenditures. The coefficients are similar to equation (4.49): the effect of tax share is positive but not significantly different from zero; the income elasticity is positive and inelastic. The elasticity of federal education aid is higher than for that of equation (4.49), as the marginal propensity of federal aid to spend is \$0.23. Coefficients of both state categorical aid and state block grants (equalization fund) are positive and significant. The elasticities are 0.2927 and 0.0102, respectively. An additional dollar of state categorical aid would result in a \$0.62 increase in spending in the districts, and an extra dollar of state equalization aid would result in a 2.55 cent increase in spending. The elasticities of state categorical aid and state equalization aid in this study can be compared with findings reported by Adams (1979), who studied unified school districts in Maryland for 1972-1976. The former is much higher than Adams' (0.074),

but the latter is lower than Adams' (0.157). This implies that the responsiveness of educational expenditure to state categorical aid had been bigger under the segregated school system than under the 1970s unified school system.

b. Results for black schools

The results of the theoretically-derived model for black schools, equation (4.44), are listed in Table 5-6. The coefficient of the tax share is negative and inelastic. The wage rate of black teachers shows a negative sign, but it is not significantly different from zero. The wage rate of white teachers reveals a positive elasticity, and it is significant. This is an unintuitive finding. The coefficients of the number of black and white pupils show negative signs, respectively, and they are significantly different from zero. The elasticity of the aggregated income term is positive and unitary elastic. This implies that when there is a percentage increase in aggregated income (whether it comes from increase in income or from a larger grant from a higher level of government), per pupil expenditure will increase by the same percentage as well. This means that an additional dollar of aggregated income leads to a 6.5 cent increase in spending.

When income and per pupil total grant are separated in equation (4.48), all but one variable show significant and inelastic estimates. Only the wage rate of white teachers is insignificant. The tax share shows a negative sign, as expected, and it is significantly different from zero at the 5% level. The coefficient of the wage rate of black teachers is positive. The elasticity of the number of black pupils is negative, as expected, but that of white pupils is positive. This unexpected sign of the elasticity of the number of white pupils will be explained

in the next section. The income elasticity is 0.5370. That is inelastic, but it is higher than the estimates of Ladd (1975), Feldstein (1975), and Black et al. (1979). An additional dollar of income leads to an increase in spending of 3.7 cents. The coefficient of per pupil total aid is 0.3777. The expenditure would be increased by \$0.29 with an additional dollar of aid.

The results of equation (4.50) are similar to equation (4.48); the signs and levels of significance of the coefficients are the same, and the values of elasticities of the parameters are quite close to one another. Here again, the coefficient of the number of white pupils is positive and significant. The elasticity of federal aid, 0.0194, implies a \$0.16 increase in spending for black education in response to a one-dollar increase in federal aid. Total state aid has a marginal propensity to spend of 0.31.

In equation (4.52), the tax share coefficient is negative, but not significantly different from zero. Other than that, the results again are similar to either equation (4.48) or (4.50). The implied marginal propensity to spend of federal aid is 0.20. State categorical aid shows an elasticity of 0.4805, which is interpreted as \$0.76 increase in spending for an additional dollar of state categorical aid. For the state equalization fund, it is 1.71 cents.

c. Comparison

When the results of black and white school districts are compared, there seem to be some similarities as well as some differences. Most coefficients are inelastic and significant. The responsiveness of expenditures to the tax share, income, and grants between the two districts are, however, somewhat different. In general, the estimates of those variables for black schools reveal higher responsiveness than for white schools. When there is an additional

dollar of either income or any type of block aid, almost all of coefficients for black schools are more responsive (elastic) than for white schools, excepting the state equalization fund. Such a high responsiveness in black schools might be due, at least partly, to the lack of funds at the beginning compared to white schools.

When the trends of the sample statistics are considered, as in Table 5-4, there are some interesting patterns for black and white schools between number of pupils and per pupil expenditure. While the average number of white pupils increased somewhat steadily over the years, the number of black pupils decreased slowly until 1946, before trending upward. Other variables, such as median income and grants (as a total, or for state and federal separately), which were great sources of public school financing, show a steady increase over the years as the size of the state's or the nation's economy grew. Thus, when the number of white pupils increased, it is expected that the voter, local educational agency, or higher levels of government would try to increase funding to facilitate the necessary expenses through property tax collection or grants. This coincided with a greater increase in per pupil expenditures for black schools than for white schools, shown in the trend of per pupil expenditure. In the early years, the ratio of black and white per pupil expenditure was about one-half. This gap had been narrowed steadily over the years. At the end of the period covered here, the gap had almost disappeared. Therefore, it can be concluded that when the number of white pupils increased, it affected positively per pupil expenditure for black schools. This might also explain the positive elasticity of the number of white pupils to expenditures for black pupils, as in equations (4.48), (4.50), and (4.52).

The higher responsiveness of expenditure to aid in black schools than in white schools can be seen in another way. The effects of aid are simulated such that, after estimating the reduced form expenditure equation, the coefficient estimates are substituted into the reduced form equation given aid being equal to zero. Then, the estimated (simulated) expenditure level is derived as if there is no federal and/or state aid to the districts. This simulated expenditure level is, of course, lower than the actual level. Now, the ratio of the difference between the actual and simulated expenditure level to the actual expenditure level is derived. This ratio implies what percentage of expenditure is accounted for by aid, that is, the degree of a district's reliance on aid to finance education expenditure. This is done separately for black and white school equations to investigate which schools showed the greater impact of aid on expenditure. This procedure is repeated for pairwise equations between (4.43) and (4.44), (4.47) and (4.48), (4.49) and (4.50), and (4.51) and (4.52). For pairwise equations (4.43) and (4.44), and (4.47) and (4.48), it is set that $G = 0$, and $g = 0$, respectively. For equations (4.49) and (4.50), it is set that either $g_f = 0$ or $g_s = 0$, separately. It is set that either $g_e = 0$ or $g_c = 0$ separately for equations (4.51) and (4.52).

The results⁴ strongly support the implication of the regression results analyzed above. The black schools more heavily depended on the aid for financing expenditure than the white schools, since in every district of any year for any type of aid, black schools show a bigger ratio than white schools. Even in the case of the state equalization fund, which showed lower elasticity in black schools than in white schools, the simulation reveals that black schools relied more on state equalization aid than white schools. Thus, it is concluded that, not only is the responsiveness of expenditure to aid in black schools higher than in white schools, but the

degree of reliance on aid for financing expenditure also is higher in black schools than in white schools. Therefore, the government education policy, which was revealed through the provision of education aid to both black and white schools, could affect black schools more than white schools.

Aid effectiveness appears to depend on whether the aid enters the expenditure function via an aggregated income term or not. The income is more elastic to the inclusion of such aid, as in equations (4.43) and (4.44). If the aid is not included in the income term, hence separated, then income elasticity becomes smaller, as in equations (4.47), (4.49), and (4.51) for white schools, and (4.48), (4.50), and (4.52) for black schools. The aid elasticity also becomes smaller when it is separated from the income term.

The federal government's role had been minimal as mentioned earlier. In 1929-1930, only 0.4% of all public school revenue receipts for 48 states came from the federal government.⁵ Although the federal share had increased over the years to 1.7% in 1939-1940, and 1.9% in 1949-1950, federal financing of education is comparatively inconsequential in nature. Maryland was typical. The state contribution to public schools had increased a lot. The state aid for all public schools in Maryland had been 19.9%, 27.8%, and 38.1% of total current expenses in 1928-1929, 1939-1940, and 1949-1950, respectively. This parallels the nation-wide trend, but remains slightly below the national average.⁶ When the total grant term is separated between federal and state levels, per pupil expenditure is remarkably less responsive to federal aid than to state aid. The elasticities of federal aid are 0.0185 and 0.0201 for white schools, and 0.0194 and 0.0235 for black schools. The elasticities of state aid are

0.2228 for white schools, and 0.3607 for black schools. State aid has a greater impact than federal aid. Low elasticity and low absolute value of federal aid could affect expenditure small.

When state aid is divided further by state categorical aid and state block grant (equalization fund), the responsiveness is different between the two types of aid, as analyzed earlier. The expenditure is much more responsive to state categorical aid than to state equalization grants. The equalization fund provided only the additional money needed by each county to maintain the state-defined minimum standards for its schools. Hence, it had been nonexistent or quite small in a number of counties (school districts) over the early years of the period covered here. It is interesting that, although the equalization fund was intended only to bring the poorest counties to the basic minimum, every county in Maryland had received this aid in later years. In 1950s, the fund supplied around one-half of all the state aid given in Maryland.

In the previous discussion, when the aid responsiveness was interpreted as an increase in expenditure with an increment in aid, one should note that both levels of per pupil expenditure for black and white schools would be determined simultaneously through the decision-making process. Thus, whenever there is additional funding available to the school districts, it would affect both black and white schools at the same time. This implies that an additional dollar of federal aid leads to an increase in spending of \$0.37 as a whole in the county (\$0.21 for white schools, plus \$0.16 for black schools) with equations (4.49) and (4.50), and of \$0.43 as a whole in the county (\$0.23 for white schools, plus \$0.20 for black schools) with equations (4.51) and (4.52). For total state aid to the districts, this marginal propensity to spend becomes 0.57 ($= 0.26 + 0.31$) with equations (4.49) and (4.50). If the

state categorical aid to a district is increased by one dollar, it would result in a \$1.38 (= \$0.62 + \$0.76) increase in expenditure as a whole in the county. Thus, state categorical aid appears to stimulate expenditure by more than the increase in the amount of aid in the county. The state equalization fund shows 4.26 cents (= 2.55 + 1.71) of marginal propensity to spend. Overall, only state categorical aid stimulates the expenditure level by more than the increase in the amount of aid. This implies that there exists a flypaper effect. When other types of aid are considered, a part of the additional funds is used to relieve the local property tax burden.

2. Nonlinear models (partial property tax shifting)

The specifications (4.53)-(4.60) are the partial shifting models with the parameter identification constraints imposed. The dependent variables are the same as in the no-property-tax-shifting models. The method of nonlinear least squares is required, and the equations are estimated using Gauss-Newton method. The results of parameter estimates are presented in Table 5-7 and 5-8. Parameter estimates and their asymptotic standard errors are listed in parentheses. The asterisk (*) next to a coefficient value indicates that it is asymptotically significantly different from zero at the 5% level. The sum of squared residuals, SSR, the value of the log-likelihood function, $L(\hat{\gamma})$, and the log-likelihood ratio, $-2\ell(\hat{\gamma})$, are also listed.

a. Results for white schools

Table 5-7 shows the parameter estimates for white schools. The own-price elasticities, α_1 , are all negative, and income and grant elasticities are all positive; all of them are significant

Table 5-7. Nonlinear least squares estimates of elasticities, congestion and shifting parameters for white schools^a

Parameter	(4.53)	(4.55)	(4.57)	(4.59)
α_1	-0.2905* (0.0488)	-0.2553* (0.0430)	-0.2489* (0.0417)	-0.2432* (0.0420)
α_2	-0.0115 (0.0467)	0.0018 (0.0435)	0.0025 (0.0423)	0.0244 (0.0433)
α_3	0.6879* (0.0243)	0.4802* (0.0286)	0.4376* (0.0290)	0.4180* (0.0303)
α_4		0.2294* (0.0143)	0.0297* (0.0036)	0.0326* (0.0035)
α_5			0.1780* (0.0158)	0.1841* (0.0212)
α_6				0.0134* (0.0033)
π_w	1.0170* (0.0661)	1.0788* (0.0627)	1.0578* (0.0591)	1.0463* (0.0584)
π_b	7.5735 (30.4356)	-35.5939 (882.8263)	-23.3276 (400.9638)	-2.0796 (3.8402)
θ	38.4548* (4.5900)	29.2289* (5.7392)	26.5926* (5.2378)	28.3665* (6.3930)
SSR	14.1320	12.6575	12.0853	12.2451
$L(\hat{\gamma})$ (Log-likelihood)	267.517	300.247	313.998	310.083
$-2\ell(\hat{\gamma})$ (Log-likelihood ratio)	238.994	227.312	194.912	175.266

a Asymptotic standard errors are in parentheses.

* asymptotically significant at the 5% level

Table 5-8. Nonlinear least squares estimates of elasticities, congestion and shifting parameters for black schools^a

Parameter	(4.54)	(4.56)	(4.58)	(4.60)
β_1	0.0521* (0.0713)	0.4498* (0.0605)	0.4702* (0.0599)	0.4747* (0.0599)
β_2	-0.8142* (0.0699)	-0.7125* (0.0608)	-0.7263* (0.0604)	-0.6708* (0.0614)
β_3	1.1419* (0.0365)	0.7687* (0.0404)	0.7325* (0.0419)	0.6712* (0.0432)
β_4		0.3533* (0.0200)	0.0329* (0.0051)	0.0382* (0.0050)
β_5			0.3004* (0.0227)	0.3737* (0.0304)
β_6				0.0085* (0.0047)
π_w	-0.3045* (0.0557)	-0.1254* (0.0381)	-0.1308* (0.0381)	-0.1442* (0.0390)
π_b	4.0816* (1.5199)	2.8422* (0.5893)	2.9987* (0.6491)	2.5446* (0.4633)
θ	22.6400* (3.4872)	7.8797* (2.1178)	7.2321* (2.0639)	6.7234* (2.5389)
SSR	31.0961	24.9082	24.7720	24.7263
$L(\hat{\gamma})$ (Log-likelihood)	33.262	99.154	100.784	101.316
$-2\ell(\hat{\gamma})$ (Log-likelihood ratio)	82.052	58.116	47.188	31.830

a Asymptotic standard errors are in parentheses.

* asymptotically significant at the 5% level

asymptotically at the 5% level. The income elasticities, α_3 , are uniformly much higher than no-property-tax-shifting estimates, but the grant elasticities show mixed results. Total aid elasticity in equation (4.55) is not much different, but a little lower than that of equation (4.47). The federal aid elasticities, 0.0297 of equation (4.57) and 0.0326 of equation (4.59), are a little higher than the values of 0.0185 of equation (4.49) and 0.0201 of equation (4.51), but still are very inelastic.

The elasticity of total state aid in equation (4.57) is 0.1780, which is lower than that of equation (4.49), 0.2228. Also, the state categorical aid shows a lower elasticity in equation (4.59) than in equation (4.51), but for the state block aid (equalization fund), they are quite close to each other and very inelastic.

The own-price elasticity of demand is very inelastic for all models in Table 5-7. These values indicate that a large local share distortion is needed to induce an appreciable expenditure response from the districts.

The shifting parameter estimates are all significant. The theory indicates that the larger the value of θ , the greater the degree of perceived shifting. These large values, therefore, indicate that residents perceive substantial shifting of nonresidential property tax onto themselves. The asymptotic t statistics provide support for the perceived shifting.

It is interesting to note that the congestion parameter estimates for white education are all close to one, as Borchering and Deacon (1972) found. These estimates indicate that education for white pupils resembles a private good. However, the congestion parameters for black education are not asymptotically significant at the 5% level, and neither are the cross-price elasticities between black and white education.

On the bottom row of the table, there are statistics showing -2 times the log-likelihood ratio, $-2\ell(\hat{\gamma})$. This statistic is used to test the significance of the function, much like the F statistic for linear functions. It is an asymptotically distributed χ^2 with K-1 degrees of freedom, where K is the number of parameters in the tested equation. Thus, the calculated values indicate that each specification is significant under the respective hypothesis.

b. Results for black schools

All parameter estimates for black schools in Table 5-8 are asymptotically significant. The own-price elasticities are all negative, ranging between -0.6708 and -0.8142. Income and grant elasticities are all positive. Likewise, in white schools, the income elasticities are uniformly higher than the no-property-tax-shifting estimates. The estimate of the aggregated income indicates an elastic response of expenditure to a change in aggregated income. Except federal aid, all other aid elasticities are lower than in the no-property-tax-shifting models, although the differences do not become large.

The shifting parameters are positive, which indicates that nonresidential property taxes are shifted onto the residents. The congestion parameters for black education show that black education is regarded as a congested good. For white education, the congestion parameters are negative, which is contrary to the theory and unintuitive.

All positive cross-price elasticities indicate that white education is regarded as a substitute for black education. Thus, if the price of white education service is increased, then the districts would increase the provision of black education.

Again, the values of the log-likelihood ratio tests imply that each specification is significant under the respective hypothesis.

c. Comparison

As in the linear models, where there occurs no property tax shifting, the estimates of black schools show higher responsiveness of expenditure to income and most grant variables, except the state equalization fund, than white schools. Thus, it can be concluded that the same reasons might be applied here as the linear models.

The shifting parameters are, however, more responsive in demand for white schools than for black schools. But the large value of the parameter estimates indicates that residents perceive substantial shifting of nonresidential property tax.

When cross-price elasticity and congestion parameters for white education are considered, the inter-racial factors do not have important roles at all, since the two estimates are not significantly different from zero. However, white education and black education become a substitute for each other in the provision of black education.

C. The Specification Tests

When there are two competing hypotheses, H_1 and H_2 , which are nonnested, the F or likelihood ratio tests are not appropriate to determine which of the hypotheses best capture the data-generating phenomenon. The goodness-of-fit criteria to test models will lead to the selection of the correct model on average if the hypotheses are nonnested and one is true a

priori. However, there is no unique goodness-of-fit statistic. Thus, this study relies on the Cox specification test to evaluate competing nonnested models.⁷

The Cox test statistic is based on the Neyman-Pearson likelihood ratio. To test the maintained hypothesis H_1 against the alternative H_2 , the appropriate statistic is the difference between the estimated log-likelihood ratio and its asymptotic expectation under the maintained hypothesis. Cox shows that this statistic divided by its standard error is an asymptotically standard normal variate. This normalized statistic can be calculated following the procedure developed by Pesaran and Deaton (1978). This test statistic is used in a one-tailed test of the maintained H_1 against the alternative H_2 . If this value is significantly negative, then H_1 is rejected in favor of H_2 . If it lies within the designated critical region, H_1 cannot be rejected and the data supports the maintained hypothesis. Similarly, H_2 can be the maintained hypothesis against the alternative H_1 , repeating the same procedure as above. Such a two-way testing allows for bilateral rejection.

Since the OLS estimates are maximum likelihood estimates under the assumptions of the models, the OLS results are used to calculate the test statistic. All the specifications (4.43), (4.47), (4.49), and (4.51) for white schools, and (4.44), (4.48), (4.50), and (4.52) for black schools are tested pairwise. The statistic values using the Cox procedure is presented in Table 5.9, and the test results are summarized in Table 5.10.

The results in Table 5.10 reveal little support for the aggregated income models.⁸ The aggregated income model for white schools, (4.43), is rejected in favor of the disaggregated income and per capita total grants formulation, (4.47). That is, using the separate income and total grants terms in the model appear to capture the data-generating phenomenon better than

Table 5-9. Normalized Cox statistic values

Maintained hypothesis	Alternative hypothesis			
<u>For white schools</u>				
	H(4.43) ₂	H(4.47) ₂	H(4.49) ₂	H(4.51) ₂
H(4.43) ₁		-128.5839*	-130.6921*	-146.4595*
H(4.47) ₁	-1.4070		-3.2385*	-7.1605*
H(4.49) ₁	-2.6786*	-2.8052*		--6.4081*
H(4.51) ₁	-2.7379*	-3.6062*	-2.3907*	
<u>For black schools</u>				
	H(4.44) ₂	H(4.48) ₂	H(4.50) ₂	H(4.52) ₂
H(4.44) ₁		-89.7349*	-82.7161*	-87.4267*
H(4.48) ₁	-2.0158		-2.2803	-5.3826*
H(4.50) ₁	-3.2720*	-3.3195*		-5.0890*
H(4.52) ₁	-3.9362*	-6.8442*	-6.0618*	

* significant at the 5% level

Table 5-10. Cox specification test results

Models tested	Conclusions
<u>For white schools</u>	
H(4.43), H(4.47)	Reject H(4.43) only
H(4.43), H(4.49)	Reject both
H(4.43), H(4.51)	Reject both
H(4.47), H(4.49)	Reject both
H(4.47), H(4.51)	Reject both
H(4.49), H(4.51)	Reject both
<u>For black schools</u>	
H(4.44), H(4.48)	Reject H(4.44) only
H(4.44), H(4.50)	Reject both
H(4.44), H(4.52)	Reject both
H(4.48), H(4.50)	Reject H(4.50) only
H(4.48), H(4.52)	Reject both
H(4.50), H(4.52)	Reject both

the aggregated income model. However, bilateral rejections for the remaining pairwise tests mean that there is no strong evidence supporting one model over another. For the black schools, the aggregated income model, (4.44), is again rejected in favor of the disaggregated income and grant model, (4.48). Model (4.48) is also favored against model (4.50), which contained the separate federal and state grants terms. The other pairwise tests again show the bilateral rejections.

Overall, the results reveal that the disaggregated income and per pupil total grants specification is favored against the aggregated income specification. However, there is no dominant model specification for both black and white schools.

Notes

1. Many education expenditure studies use average daily attendance instead of average daily belonging. However, when state aid or other funds are calculated and provided in Maryland, enrollment figure had been used according to *Maryland General Code*. (See *Report of Maryland Commission to Study Public Education and Finances*, 1952, p.45) Note that since attendance and enrollment are highly correlated, a correlation of 0.99977 for white pupils and of 0.99735 for black pupils, the result of using either one may not be significantly different from using the other.
2. These data sets are drawn from Dr. TenHoeve's (1992) dissertation.
3. Borcharding and Deacon (1972) used average (mean) income for their analysis for the same reason as here. However, if the median income data were available, it would give better results, as Pommerehne and Frey (1976), Pommerehne (1978), and Mathis and Zech (1986) showed.
4. The simulation results are presented here descriptively only, but not shown, since the volume of output is too much to fit in.
5. See *Report of Maryland Commission to Study Public Education and Finances*, 1952, p.28.
6. *op. cit.* p.37.
7. The use of the Cox specification test is shown in Turnbull (1987), and this study quotes and follows what he suggested.
8. This result is similar to Turnbull's (1987).

CHAPTER VI. SUMMARY AND CONCLUSION

The preceding chapters have compared the expenditure behavior between black and white school districts in Maryland for the years 1929 through 1955, where a segregated school system existed. Chapter II provided the necessary background information on intergovernmental grants-in-aid and a literature review, and Chapter III provided the premises of the median voter model of local expenditure determinants together with some empirical specification problems involved with education. It was assumed that voters of a school district vote in accordance with their single-peaked preferences for education, and that the majority-rule decision would decide levels of public service within the governmental budgetary constraint. Under these assumptions, a plausible case was made for a median outcome. That is, it was postulated that the observed spending level equals the median voter's preferred one.

On this basis, in Chapter IV, the theoretical model and the specific estimating equations were derived under the segregated school system, where a median voter chooses both black and white schoolings. The no-property-tax-shifting models and partial-property-tax-shifting models were specified separately. Note that the theoretically-derived model is unique in the sense that inter-racial factors were considered to determine the expenditure level for both black and white schools simultaneously. This implies that the demand for education for whites, for example, is not only a function of white teachers' wage rate and the number of white pupils, but also a function of black teachers' wage rate and the number of black pupils, and similarly for education for blacks.

Data were collected for the 23 white school districts and the 22 black school districts in Maryland. In Chapter V, the methods of ordinary least squares and nonlinear least squares were employed to obtain parameter estimates for no-nonresidential-property-tax-shifting models and partial-nonresidential-property-tax-shifting models, respectively. Then, the empirical estimates were evaluated.

Generally, the price elasticity of demand was low. That is, the tax share coefficients were negative, as expected, but expenditure was not very responsive to tax share. When income and aid variables were treated separately, the effect on expenditure was small except for state categorical aid, which stimulates expenditure by more than the incremental amount of aid. Other grants served primarily to relieve the property tax burden in the district.

Estimates of shifting parameters were high and significant, indicating that voters perceived that a relatively high share of the nonresidential property tax was shifted to them, rather than exported.

The estimates of a congestion parameter suggested that education for whites was regarded as a private good and education for black is regarded as a public good in determining the expenditure level of white education. However, education for blacks was revealed as a congested good in determining the expenditure level of black education.

When black and white schools were compared, the expenditure or the demand for education in black schools was much more responsive to income and to most types of aid than in white schools. In addition, it was shown that black schools more heavily depended on aid to financing expenditure than white schools by the results of simulation. This could explain why

the gap of per pupil expenditure between black and white schools narrowed over the period.

This may be explained by the following factors.

With the median voter model and the proportion of the population between black and white being considered, the median voters in the districts in Maryland over the period would be whites. The more affluent whites evidently were motivated to increase expenditure on black schools. Whether they acted for philanthropic or altruistic reasons, or obtained positive externalities from the education of blacks, since schooling teaches respect for the customs and mores of a society and education transforms blacks to be a better work force for whites, needs to be investigated further.

Margo (1982), Pritchett (1985) and Gerber (1991) studied public school expenditure in the southern states at the turn of the century, from the late 1800s to the early 1900s, when blacks were disfranchised. They showed that the school board or local agency helped to fund white education by appropriating some of the receipts from black property taxes and the black share of state funds that were redistributed to counties on the basis of school population. Even though there are no specific data on taxes collected from the black population and on how state aid was distributed to black schools in Maryland for the period covered in this study, it is hard to imagine that such a discriminatory policy had been exercised since there was no disfranchisement of blacks. The blacks as a whole might even form as a political pressure group to "vote with their feet" in order to improve their economic and social positions. As a result, the gap between black and white narrowed, to be almost equal, at least in per pupil expenditure, at the end of the segregated school era. However, equality in expenditure level, and, hence reduction of the gap in economic and social well-being in the future, between

blacks and whites, could have been achieved much faster had there been a way to allocate more of available state and federal grants-in-aid to black schools so as to stimulate the median voter's spending on black schools, since the responsiveness of expenditure to and the dependency on grants in black schools were greater in general than in white schools.

The Cox specification test results showed that there is no dominant model specification among four competing equations for both black and white schools, though the disaggregated income and total grants specification is favored against the aggregated income specification. Thus, more theoretical development of the voting model might be called for in terms of the responsiveness of expenditure to income and grants. It is plausible that a voter's perceived share of education grants may not have the same effect on expenditure as income.

There are some other issues to be considered for further research in extension of this study. First, the supply-side of education needs to be considered further. The assumption that the production process has constant to returns to scale may be too strong. The average cost function could be a well-behaved U-shaped curve in the long run, and school operation could also be at increasing or decreasing cost. Hence, the production process in education could show decreasing or increasing returns to scale. The user cost of capital, in another aspect, could vary across counties and/or over the period. This allowance for variation in capital would give better results to explain the effect of aid on expenditure. Also, the shape of demand curves for black and white education could be considered; whether or not the lower elasticity estimates for white than for black demand are a consequence of the larger output produced, Q , for white education; whether or not there was a hidden supply effect (higher cost of black education after a 1941 court decision, which required equal salary payment for

teachers with the same skill regardless of race) that might complement shifts in demand for black education, thereby causing convergence in per pupil expenditure between black and white schools.

With the modeling of the median voter hypothesis, the cyclical voting problem might occur. By including both black and white spending as separate issues, this might weaken the case for the single-peaked preference assumption, hence the cyclical majority problem. This might require a further investigation. Also, with the congestion parameters, it could be considered that π_w and π_b are the same for black expenditure and white expenditure estimates, but that the behavioral response differs.

REFERENCES

- Adams, E. Kathleen, *Analyses and Comparison of Fiscal Response in Four States*, Denver, Colo.: Education Finance Center, Education Commission of the States, December 1979.
- Adams, E. Kathleen, *Fiscal Responses and School Finance Simulations: A Policy Perspective*, Denver, Colo.: Education Finance Center, Education Commission of the States, December 1980.
- Addonizio, Michael F., "Intergovernmental Grants and the Demand for Local Educational Expenditures," *Public Finance Quarterly*, April 1991, 19(2), 209-232.
- Atkinson, Anthony B. and Joseph Stiglitz, *Lectures on Public Economics*, New York; McGraw-Hill, 1980.
- Bahl, Roy W., Marvin Johnson and Michael Wasylenko, "A Public Employment Model," in Roy Bahl, Jesse Burkhead and Bernard Jump, Jr., eds., *Public Employment and Local Government Finance*, Cambridge, Mass.: Ballinger Publishing Company, 1980, 121-154.
- Barr, James L. and Otto A. Davis, "An Elementary Political and Economic Theory of the Expenditure of Local Governments," *Southern Economic Journal*, October 1966, 33(2), 149-165.
- Barro, S. M., *Theoretical Models of School District Expenditure Determination and the Impact of Grants-in-Aid*, R-867-FF, Santa Monica, Calif.: The Rand Corporation, 1972.
- Baum, Donald N., "A Simultaneous Equations Model of the Demand for and Production of Local Public Services: The Case of Education," *Public Finance Quarterly*, April 1986, 14(2), 157-178.
- Beck, John H., "Budget-Maximizing Bureaucracy and the Effects of State Aid on School Expenditures," *Public Finance Quarterly*, April 1981, 9(2), 159-182.
- Bergstrom, Theodore C. and Robert P. Goodman, "Private Demands for Public Goods," *American Economic Review*, June 1973, 63(3), 280-296.
- Bergstrom, Theodore C., Daniel L. Rubinfeld and Perry Shapiro, "Micro-Based Estimates of Demand Functions for Local School Expenditures," *Econometrica*, September 1982, 50(5), 1183-1205.

- Billings, R. Bruce and Roger Nils Folsom, "Voter Perception of Property Tax Incidence as Revealed by School Expenditure Decisions," *National Tax Journal*, December 1980, 33(4), 459-471.
- Bishop, George A., "Stimulative versus Substitutive Effects of State School Aid in New England," *National Tax Journal*, June 1964, 17(2), 133-143.
- Black, David E., Kenneth A. Lewis and Charles R. Link, "Wealth Neutrality and the Demand for Education," *National Tax Journal*, June 1979, 32(2), 157-164.
- Black, David E., Kenneth A. Lewis and Charles R. Link, "Wealth Neutrality and the Demand for Education: A Response," *National Tax Journal*, June 1980, 33(2), 239-241.
- Black, Duncan, *The Theory of Committees and Elections*, Cambridge, Mass.: Cambridge University Press, 1958.
- Booms, Bernard H. and Teh-Wei Hu, "Toward a Positive Theory of State and Local Public Expenditures: An Empirical Example," *Public Finance*, 1971, 26(3), 419-436.
- Borcherding, Thomas E. and Robert T. Deacon, "The Demand for Services of Non-Federal Governments," *American Economic Review*, December 1972, 62(5), 891-901.
- Bowen, H., "The Interpretation of Voting in the Allocation of Economic Resources," *Quarterly Journal of Economics*, November 1943, 28(1), 27-48.
- Bowman, John H., "Tax Exportability, Intergovernmental Aid, and School Finance Reform," *National Tax Journal*, June 1974, 27(2), 163-173.
- Bradford, David F. and Wallace E. Oates, "Towards a Predictive Theory of Intergovernmental Grants," *American Economic Review*, May 1971, 61(2), 440-448.
- Brazer, Harvey E., *City Expenditures in the United States*, Occasional Paper 66, National Bureau of Economic Research, 1959.
- Brazer, Harvey E. and Therese A. McCarty, "Interaction Between Demand for Education and for Municipal Services," *National Tax Journal*, December 1987, 40(4), 555-566.
- Campbell, A. and S. Sacks, *Metropolitan America, Fiscal Patterns and Governmental Systems*, Glencoe, N.Y.: Free Press, 1967.
- Chang, Cyril F., "Different Forms of Outside Aid: A Collective-Choice Model for Predicting Effects on Local Educational Expenditure," *Public Finance Quarterly*, July 1981, 9(3), 321-341.

- Clyde, R. W., *Educational Expenditure Determinant Study: A Supply and Demand Approach*, Unpublished Thesis, University Park, Pennsylvania State University, 1973.
- Cohn, Elchanan, *Economics of State Aid to Education*, Lexington, Mass.: Heath Lexington Books, 1974.
- Cox, D. R., "Tests of Separate Families of Hypotheses," in *Proceedings of the Fourth Berkeley Symposium on Mathematical Statistics and Probability*, Vol. 1, Berkeley: University of California Press, 1961, 105-123.
- Cox, D. R., "Further Results on Tests of Separate Families of Hypotheses," *Journal of Royal Statistical Society, Series B*, 1962, 24(2), 406-424.
- Craig, Steven G. and Robert P. Inman, "Federal Aid and Public Education: An Empirical Look at the New Fiscal Federalism," *Review of Economics and Statistics*, November 1982, 64(4), 541-552.
- Deno, Kevin T. and Stephen L. Mehay, "Municipal Management Structure and Fiscal Performance: Do City Managers Make a Difference?" *Southern Economic Journal*, January 1987, 53(3), 627-642.
- Denzau, Arthur, "An Empirical Survey of Studies on Public School Spending," *National Tax Journal*, June 1975, 28(2), 241-249.
- Denzau, Arthur and Kevin Grier, "Determinants of Local School Spending: Some Consistent Estimates," *Public Choice*, 1984, 44(2), 375-383.
- Downs, Anthony, *An Economic Theory of Democracy*, New York: Harper and Row, 1957.
- Feldstein, Martin S., "Wealth Neutrality and Local Choice in Public Education," *American Economic Review*, March 1975, 65(1), 75-89.
- Feldstein, Martin S., "The Effect of a Differential Add-on Grant: Title I and Local Education Spending," *Journal of Human Resources*, Fall 1978, 13(4), 443-458.
- Feldstein, Martin S., "Public Education: Reply," *American Economic Review*, September 1984, 74(4), 820-821.
- Filimon, Radu, Thomas Romer and Howard Rosenthal, "Asymmetric Information and Agenda Control: The Bases of Monopoly Power in Public Spending," *Journal of Public Economics*, February 1982, 17(1), 51-70.

- Fishback, Price V., "Can Competition Among Employers Reduce Governmental Discrimination? Coal Companies and Segregated Schools in West Virginia in the Early 1900s," *Journal of Law and Economics*, October 1989, 32(2) (Pt. 1), 311-328.
- Fisher, Ronald C., "A Theoretical View of Revenue Sharing Grants," *National Tax Journal*, June 1979, 32(2), 173-184.
- Fisher, Ronald C., "Income and Grant Effects on Local Expenditure: The Flypaper Effect and Other Difficulties," *Journal of Urban Economics*, November 1982, 12(3), 324-345.
- Gerber, Jim, "Public School Expenditures in the Plantation States, 1910," *Explorations in Economic History*, July 1991, 28(3), 309-322.
- Gramlich, Edward M., "Alternative Federal Policies for Stimulating State and Local Expenditures: A Comparison of Their Effects," *National Tax Journal*, June 1968, 21(2), 119-129.
- Gramlich, Edward M., "The Effects of Federal Grants on State-Local Expenditures: A Review of the Econometric Literature," *National Tax Association Papers and Proceedings*, 1969, 569-593.
- Gramlich, Edward M., "Intergovernmental Grants: A Review of the Empirical Literature," in W. E. Oates, ed., *The Political Economy of Fiscal Federalism*, Lexington, Mass.: Lexington, 1977, 219-239.
- Gramlich, Edward M. and Harvey Galper, "State and Local Fiscal Behavior and Federal Grant Policy," in A. Okun and G. Perry, eds., *Brookings Papers on Economic Activity 1*, Washington, D.C.: The Brookings Institution, 1973, 15-65.
- Gramlich, Edward M. and Daniel L. Rubinfeld, "Micro Estimates of Public Spending Demand Functions and Tests of the Tiebout and Median-Voter Hypotheses," *Journal of Political Economy*, June 1982, 90(3), 536-560.
- Greene, Kenneth V. and Vincent G. Munley, "Perceptions of the Ability to Export Nonresidential Property Tax Burdens," *Public Finance Quarterly*, January 1984, 12(1), 117-127.
- Grubb, W. Norton and Stephen Michelson, *States and Schools*, Lexington, Mass.: Lexington Books, 1974.
- Grubb, W. Norton and Jack W. Osman, "The Causes of School Finance Inequalities: Serrano and the Case of California," *Public Finance Quarterly*, July 1977, 5(3), 373-392.
- Hamilton, Bruce W., "The Flypaper Effect and Other Anomalies," *Journal of Public Economics*, December 1983, 22(3), 347-361.

- Hirsch, Werner Z., *The Economics of State and Local Government*, McGraw-Hill, New York, N.Y., 1970.
- Holcombe, Randall G., "An Empirical Test of the Median Voter Model," *Economic Inquiry*, April 1980, 18(2), 260-274.
- Holcombe, Randall G., *Public Finance and the Political Process*, Carbondale: Southern Illinois University Press, 1983.
- Holcombe, Randall G., "The Median Voter Model in Public Choice Theory," *Public Choice*, May 1989, 61(2), 115-125.
- Hotelling, H., "Stability in Competition," *Economic Journal*, March 1929, 39, 41-57.
- Hu, Teh-Wei and Bernard H. Booms, "A Simultaneous Equation Model of Public Expenditure Decisions in Large Cities," *Annals of Regional Science*, 1971, 5, 73-85.
- Inman, Robert P., "Towards an Econometric Model of Local Budgeting," *Proceedings of the 64th Annual Conference on Taxation of the National Tax Association*, 1971, 699-719.
- Inman, Robert P., "Optimal Fiscal Reform of Metropolitan Schools: Some Simulation Results," *American Economic Review*, March 1978, 68(1), 107-122.
- Inman, Robert P., "Testing Political Economy's 'as if' Proposition: Is the Median Income Voter Really Decisive?," *Public Choice*, 1978, 33(4), 45-65.
- Johnson, Marvin B., "Community Income, Intergovernmental Grants, and Local School District Fiscal Behavior," in Peter Mieszkowski and William Oakland, eds., *Fiscal Federalism and Grants-in-Aid*, Washington, D.C.: The Urban Institute, 1979, 51-77.
- Judge, George G., R. Carter Hill, William E. Griffith, Helmut Lutkepohl and Tsoung-Chao Lee, *Introduction to the Theory and Practice of Econometrics*, New York, N.Y.: John Wiley & Sons, 1982.
- Juster, F. T., *The Economic and Political Impact of General Revenue Sharing*, Washington, D.C.: National Science Foundation, April 1976.
- Ladd, Helen F., "Local Education Expenditures, Fiscal Capacity, and the Composition of the Property Tax Base," *National Tax Journal*, June 1975, 28(2), 145-158.
- Leekley, Robert M., "Multiple Outputs and Community Choice in Public Education," *Economic Inquiry*, July 1980, 18(3), 333-352.

- Levin, H. M. and Mun C. Tsang, "Federal Grants and National Educational Policy," in Esther Tron, ed., *Adequate Education: Issues in Its Definition and Implementation*, School Finance Project, Working Papers, Office of Educational Research and Improvement, Washington, D.C., July 1982, 269-306.
- Logan, Robert R., "Fiscal Illusion and the Grantor Government," *Journal of Political Economy*, December 1986, 94(6), 1304-1318.
- Lovell, Michael C., "Spending for Education: The Exercise of Public Choice," *Review of Economics and Statistics*, November 1978, 60(4), 487-495.
- Margo, Robert A., "Race Differences in Public School Expenditures: Disfranchisement and School Finance in Louisiana, 1890-1910," *Social Science History*, Winter 1982, 6(1), 9-34.
- Maryland Commission to Study Public Education and Finance, *Report*, Annapolis, 1952.
- Maryland State Board of Education, *Annual Reports*, Annapolis, various issues.
- Mathis, Edward J. and Charles E. Zech, "An Examination into the Relevance of the Median Voter Model: Empirical Evidence Offers Support for the Model and Certain Uses," *American Journal of Economics and Sociology*, October 1986, 45(4), 403-412.
- McEachern, William A., "Collective Decision Rules and Local Debt Choice: A Test of the Median-Voter Hypothesis," *National Tax Journal*, June 1978, 31(2), 129-136.
- McKelvey, Richard D., "Intransitivities in Multidimensional Voting Models and Some Implications for Agenda Control," *Journal of Economic Theory*, June 1976, 12(3), 472-482.
- McMahon, Walter W., "An Economic Analysis of Major Determinants of Expenditures on Public Education," *Review of Economics and Statistics*, August 1970, 52(3), 242-252.
- Megdal, Sharon Bernstein, "The Determination of Local Public Expenditures and the Principal and Agent Relation: A Case Study," *Public Choice*, 1983, 40(1), 71-87.
- Megdal, Sharon Bernstein, "A Model of Local Demand for Education," *Journal of Urban Economics*, July 1984, 16(1), 13-30.
- Miner, J., *Social Economic Factors in Spending for Public Education*, Syracuse, N.Y.: Syracuse University Press, 1963.
- Mueller, Dennis C., *Public Choice II*, Cambridge, MA.: Cambridge University Press, 1989.
- Munley, Vincent G., "Has the Median Voter Found a Ballet Box That He Can Control?" *Economic Inquiry*, July 1984, 22(3), 323-336.

- Nathan, R. P. and C. F. Adams, *Revenue Sharing: The Second Round*, Washington, D.C.: Brookings Institution, 1977.
- Nathan, R. P., A. D. Menvel, S. E. Calkins and Associates, *Monitoring Revenue Sharing*, Washington, D.C.: Brookings Institution, 1975.
- Niskanen, William A., *Bureaucracy and Representative Government*, Aldine-Atherton, Chicago, 1971.
- Oates, Wallace E., *Fiscal Federalism*, New York: Harcourt Brace Jovanovich, Inc., 1972.
- O'Brien, Thomas, "Grants-in-Aid: Some Further Answers," *National Tax Journal*, March 1971, 24(1), 65-78.
- Orazem, Peter F., "Black-White Differences in Schooling Investment and Human Capital Production in Segregated Schools," *American Economic Review*, September 1987, 77(4), 714-723.
- Osman, Jack W., "The Dual Impact of Federal Aid on State and Local Government Expenditures," *National Tax Journal*, December 1966, 19(4), 362-372.
- Park, Rolar Edward and Stephen J. Carroll, *The Search for Equity in School Finance: Michigan School District Response to a Guaranteed Tax Base*, R-2393-NIE/HEW, Santa Monica, Calif.: The Rand Corporation, 1979.
- Perkins, George M., "The Demand for Local Public Goods: Elasticities of Demand for Own Price, Cross Prices, and Income," *National Tax Journal*, December 1977, 30(4), 411-422.
- Perkins, George M., "Public Education: Comment," *American Economic Review*, September 1984, 74(4), 814-819.
- Pesaran, M. H., "On the General Problem of Model Selection," *Review of Economic Studies*, April 1974, 41(2), 153-171.
- Pesaran, M. H. and A. S. Deaton, "Testing Non-Nested Nonlinear Regression Models," *Econometrica*, May 1978, 46(3), 677-694.
- Pesaran, M. H. and A. D. Hall, "Tests Non-Nested Linear Regression Models Subject to Linear Restrictions," *Economics Letters*, 1988, 27(4), 341-348.
- Pidot, George B., Jr., "A Principal Components Analysis of the Determinants of Local Government Fiscal Patterns," *Review of Economics and Statistics*, May 1969, 51(2), 176-188.

- Pindyck, Robert S. and Daniel Rubinfeld, *Econometric Models and Economic Forecasts*, New York, N.Y.: McGraw-Hill, 1981.
- Pogue, Thomas F. and L. G. Sgontz, "The Effects of Grants-in-Aid on State-Local Spending," *National Tax Journal*, June 1968, 21(2), 190-199.
- Pommerehne, Werner W., "Institutional Approaches to Public Expenditure: Empirical Evidence from Swiss Municipalities," *Journal of Public Economics*, April 1978, 9(2), 255-280.
- Pommerehne, Werner W. and Bruno S. Frey, "Two Approaches to Estimating Public Expenditures," *Public Finance Quarterly*, October 1976, 4(4), 395-407.
- Pritchett, Jonathan B., "North Carolina's Public Schools: Growth and Local Taxation," *Social Science History*, Summer 1985, 9(3), 277-291.
- Renshaw, Edward F., "A Note on the Expenditure Effect of State Aid to Education," *Journal of Political Economy*, April 1960, 68(2), 170-174.
- Romer, Thomas and Howard Rosenthal, "Political Resource Allocation, Controlled Agendas, and the Status Quo," *Public Choice*, 1978, 33(4), 27-43.
- Romer, Thomas and Howard Rosenthal, "The Elusive Median Voter," *Journal of Public Economics*, October 1979, 12(2), 143-170.
- Romer, Thomas and Howard Rosenthal, "Bureaucrats versus Voters: On the Political Economy of Resource Allocation by Direct Democracy," *Quarterly Journal Of Economics*, November 1979, 93(4), 563-587.
- Romer, Thomas and Howard Rosenthal, "Median Voters or Budget Maximizers: Evidence from School Expenditure Referenda," *Economic Inquiry*, October 1982, 20(4), 556-578.
- Rubinfeld, Daniel L., "The Economics of Local Public Sector," in Alan J. Auerbach and Martin Feldstein, eds., *Handbook of Public Economics*, Amsterdam: North-Holland, 1987.
- Sacks, Seymour and Robert Harris, "The Determinants of State and Local Government Expenditures and Intergovernmental Flows of Funds," *National Tax Journal*, March 1964, 17(1), 75-85.
- Sacks, Seymour and D. Ranney, "Suburban Education: A Fiscal Analysis," *Urban Affairs Quarterly*, 1966, 2(1), 103-119.
- Sacks, Seymour, D. Ranney and R. Andrew, *City Schools/Suburban Schools*, Syracuse, N.Y.: Syracuse University Press, 1972.

- Slack, Enid, "Local Fiscal Response to Intergovernmental Transfers," *Review of Economics and Statistics*, August 1980, 62(3), 364-370.
- Smith, David L., "The Response of State and Local Governments to Federal Grants," *National Tax Journal*, September 1968, 21(3), 349-357.
- Stern, David, "Effects of Alternative State Formulas on the Distribution of Public School Expenditures in Massachusetts," *Review of Economics and Statistics*, February 1973, 55(1), 91-97.
- Struyk, Raymond J., "Effects of State Grants-in-Aid on Local Provision of Education and Welfare Services in New Jersey," *Journal of Regional Science*, 1970, 10(2), 225-235.
- TenHoeve, Thomas, III., *Segregated Schools, Investment in Education, and Property Values in Maryland School Districts: 1924-1955*, Ph.D. Dissertation, Iowa State University, 1992.
- Theil, Henri, *Introduction to Econometrics*, Englewood Cliffs, N.J.: Prentice-Hall Inc., 1978.
- Tresch, Richard W., "Estimating State Expenditure Functions: An Empirical Tests of the Time Series Informational Content of Cross Section Estimates," *Public Finance (Finances Publiques)*, 1974, 29(3-4), 370-385.
- Tsang, Mun and Henry M. Levin, *The Impact of Intergovernmental Grants on Educational Spending*, Stanford University, Calif.: Institute for Research on Educational Finance and Governance, 1982.
- Tullock, Gordon, "Why So Much Stability?" *Public Choice*, 1982, 37(2), 189-202.
- Turnbull, Geoffrey K., "Alternative Local Public Education Expenditure Functions: An Econometric Evaluation," *Public Finance Quarterly*, January 1987, 15(1), 45-60.
- Turnbull, Geoffrey K. and Salpie S. Djoundourian, "The Median Voter Hypothesis: Evidence from General Purpose Local Governments," *Public Choice*, December 1994, 81(3-4), 223-240.
- U.S. Department of Commerce, *Census of the U.S.*, Bureau of the Census, U.S. Government Printing Office, Washington, D.C., 1930, 1940, 1950, and 1960.
- U.S. Department of Commerce, *Regional Employment by Industry, 1940-1970, A Supplement to the Survey of Current Business*, U.S. Government Printing Office, Washington, 1975.
- U.S. Department of Commerce, *State Personal Income: 1929-1987*, Bureau of Economic Analysis, U.S. Government Printing Office, Washington, July 1989.

- Vincent, Phillip E. and E. Kathleen Adams, *Fiscal Response of School Districts: A Study of Two States - Colorado and Minnesota*, Denver, Colo.: Education Finance Center, Education Commission of the States, October 1978.
- Vogel, Mary E., "Education Grant Consolidation: Its Potential Fiscal and Distributive Effects," *Harvard Educational Review*, May 1982, 52(2), 169-188.
- Weicher, John C., "Aid, Expenditure, and Local Government Structure," *National Tax Journal*, December 1972, 25(4), 573-583.
- Welch, Finis, "Black-White Differences in Returns to Schooling," *American Economic Review*, December 1973, 63(5), 893-907.
- Wendling, W., *The Cost of Education Index: Measurement of Price Differences of Education Personnel Among New York State School District*, Working Paper No. 26, Denver, Colo.: Education Finance Center, Education Commission of the States, April, 1980.
- Wilde, James A., "The Expenditure Effects of Grant-in-Aid Programs," *National Tax Journal*, September 1968, 21(3), 340-348.
- Wilde, James A., "Grants-in-Aid: The Analytics of Design and Response," *National Tax Journal*, June 1971, 24(2), 143-155.
- Wyckoff, Paul Gary, "A Bureaucratic Theory of Flypaper Effect," *Journal of Urban Economics*, January 1988, 23(1), 115-129.
- Wyckoff, Paul Gary, "The Elusive Flypaper Effect," *Journal of Urban Economics*, November 1991, 30(3), 310-328.

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